TM 11-6625-422-35/3

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

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FIELD AND DEPOT MAINTENANCE MANUAL

OSCILLOSCOPE OS-119/GGM

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HEADQUARTERS, DEPARTMENT OF THE ARMY
6 MARCH 1962

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the interior of the OS-119/GGM or on the 117-volt ac line connections. Serious injury or death may result from contact with high-voltage points inside the OS-119/GGM or with the ac line connections.

EXTREMELY DANGEROUS VOLTAGES EXIST INSIDE THE OS-119/GGM AT THE FOLLOWING PLACES:

Cathode-ray tube (aquadag)	+375 volts
Power supply	-2,300 volts

REGULATOR V17 (OA2WA) IN THE OS-119/GGM POWER SUPPLY CONTAINS RADIOACTIVE MATERIAL.

The OA2WA may be handled, stored, and used in a normal manner, but defective and broken tubes must be disposed of in accordance with TB SIG 225.

DON'T TAKE CHANCES!

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DS, GS, AND DEPOT MAINTENANCE MANUAL
OSCILLOSCOPE OS-119/GGM

TM 11-6625-422-35/3, 6 March 1962, is changed as follows:

The title is changed as shown above.

Page 2, paragraph 1. Delete subparagraph *d* and substitute:

d. Reporting of errors, omissions, and recommendations for improving this manual by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to Commanding General, U.S. Army Electronics Command, ATTN: AMSEL-MR-NMP-AD, Fort Monmouth, N.J., 07703.

Page 53, paragraph 38*c*, "Performance standard" column. Make the following changes:

Step No. 2. Change 300 milliseconds ±15 to: minimum 300 milliseconds.

Step No. 3. Change 75 milliseconds ±3.75 to: maximum 75 milliseconds.

Step No. 4. Change 80 milliseconds ±4 to: minimum 80 milliseconds.

Step No. 5. Change 25 milliseconds ±1.25 to: maximum 25 milliseconds.

Step No. 6. Change 30 milliseconds ±1.5 to: minimum 30 milliseconds.

Step No. 7. Change 7.5 milliseconds ±0.375 to: maximum 7.5 milliseconds.

Step No. 8. Change 8 milliseconds ±0.4 to: minimum 8 milliseconds.

Step No. 9. Change 2.5 milliseconds (2,500 microseconds) ±0.125 (125 microseconds) to: maximum 2.5 milliseconds.

Step No. 10. Change 3 milliseconds (3,000 microseconds) ±0.15 (150 microseconds) to: minimum 3 milliseconds.

Step No. 11. Change 0.75 milliseconds (7,500 microseconds) ±0.0375 (37.5 microseconds) to: maximum 0.75 milliseconds.

Page 55, paragraph 39, "Perfromance standard" column. Delete Test No. 4 and substitute:

FINE control setting:	Indication:
Maximum counter-clockwise (CCW)	300 minimum
Maximum clockwise (CW)	75 maximum
Maximum CW	25 maximum
Maximum CCW	80 minimum
Maximum CCW	30 minimum
Maximum CW	7.5 maximum
Maximum CW	2.5 maximum
Maximum CCW	8 minimum
Maximum CCW	3 minimum
Maximum CW	.75 maximum

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  WSMR (5)
  Ft Carson (19)
  Ft Knox (12)
Svc Colleges (2)
Br Svc Sch (2) except
  USASCS (20)
  USASESCS (40)
USATC Armor (2)
USATC Inf (2)
USASTC (2)
Gen Dep (2)
Sig Sec, Gen Dep (5)
Sig Dep (12)
Army Dep (3) except
  LBAD (14)
  SAAD (30)
  TOAD (14)
  ATAD (10)
AMS (1)
WRAMC (1)
Army Pic Cen (2)
USAERDAA (2)
USAERDAW (13)
USACRREL (2)
Sig FLDMS (2)
Units org under fol TOE:—2 ea.
  11-57
  11-97
  11-98
  11-117
  11-127
  11-155
  11-157
  11-158
  11-500(AA-AC)
  11-587
  11-592
  11-597

NG: State AG (3); units—same as active Army except allowance is one (1) copy each.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

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Technical Manual
No. 11-6625-422-35/3

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HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *6 March 1962*

OSCILLOSCOPE OS-119/GGM

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CHAPTER 1
THEORY

Section I. BLOCK DIAGRAM ANALYSIS

1. Scope

a. This manual covers field and depot maintenance for Oscilloscope OS-119/GGM. It includes instructions appropriate to fourth echelons for troubleshooting, adjusting, testing, and repairing the OS-119/GGM, and replacing specified maintenance parts. It also lists tools and test equipment required for fourth and fifth echelon maintenance and testing. Troubleshooting and repair will not be performed at third echelon.

b. The complete manual for this equipment includes TM 11-6625-422-12.

c. Refer to DA Pamphlet 310-4 to determine what Changes to or revisions of this publication are current.

d. Forward comments concerning this manual to the Commanding Officer, U. S. Army Signal Materiel Support Agency, ATTN: SIGMS-PA2d, Fort Monmouth, N. J.

Note: For applicable forms and records, refer to paragraph 2 of TM 11-6625-422-12.

2. General

Oscilloscope OS-119/GGM is a component of Test Sets, Teletypewriter AN/GGM-1, AN/GGM-2, AN/GGM-3, and AN/GGM-4 (TM 11-6625-422-12). The OS-119/GGM provides a means of visually examining the loop input signal to Test Set, Teletypewriter TS-1512/GGM. Block diagram analysis of the OS-119/GGM is covered in paragraph 3 through 8. Circuit analysis is covered in paragraphs 9 through 17.

3. Vertical Amplifier Channel (fig. 23)

The vertical input (loop input signal being analyzed) from the TS-1512/GGM is applied through vertical cathode follower V5B to vertical deflection amplifier V6. The output from each half of push-pull vertical deflection amplifier V6 is applied directly to a vertical deflection plate (pins 7 and 8) of the cathode-ray tube (crt). The vertical amplifier channel includes the vertical gain and vertical centering controls.

4. Horizontal Amplifier Channel (fig. 23)

Note: When the TS-1512/GGM is analyzing start-stop input signals, a 128 bit-per-unit interval digital sweep voltage is applied from the TS-1512/GGM as a horizontal input to the OS-119/GGM. The horizontal input is automatically synchronized with the stop-mark to start-space transition of the vertical input (fig. 1).

a. Input.

(1) *AUTO position of SWEEP OPTIONS switch.* The horizontal input from the TS-1512/GGM is applied through horizontal cathode follower V5A, segment Z of switch S1B (SWEEP OPTIONS), and through push-pull horizontal sweep amplifier V10 to horizontal deflection amplifier V11.

(2) *TRIGGERED and FREE positions of SWEEP OPTIONS switch.* The horizontal sweep sawtooth input from sweep cathode follower V8B (para 5*b* and *c*) is applied through segment Z of switch S1B (SWEEP OPTIONS) and push-pull horizontal sweep amplifier V10 to horizontal deflection amplifier V11.

b. Output. The output of each half of push-pull horizontal deflection amplifier V11 is applied directly to a horizontal deflection plate (pins 10 and 11) of the crt. The horizontal amplifier channel includes the horizontal gain and horizontal centering conrols.

5. Horizontal Sweep Section (fig. 23)

The function of the horizontal sweep

section depends on the setting of the SWEEP OPTIONS switch. In general, the horizontal sweep section provides an unblanking voltage for retrace blanking gate V7B. When the SWEEP OPTIONS switch is at TRIGGERED and FREE (*b* and *c* below), the horizontal sweep section generates the horizontal sweep voltage for the crt.

Note: Sweep gate generator V4 functions as a bistable when the SWEEP OPTIONS switch is at AUTO and TRIGGERED, and as a monostable, at FREE.

a. AUTO Position of SWEEP OPTIONS Switch. When the SWEEP OPTIONS switch is at AUTO:

(1) Sweep gate generator V4 is set by the output of sync gate V1A (para 6), and is reset by the blanking input from the TS-1512/GGM (applied through retrace trigger V1B). The output of sweep gate generator V4 is applied to retrace blanking gate V7B (para 7).

(2) The horizontal input (sweep voltage) from the TS-1512/GGM is applied to the horizontal amplifier channel (para 4).

b. TRIGGERED Position of SWEEP OPTIONS Switch.

(1) When the SWEEP OPTIONS switch is at TRIGGERED, sweep gate generator V4 is set by the output from sync gate V1A (para 6) and reset by the output from sweep reset trigger V3 (through retrace trigger V1B). Sweep reset trigger V3, in turn, is triggered by the output from sweep cathode follower V8B ((3) below).

(2) The output from sweep gate generator V4 is applied to permit sweep charge gate V8A to function. Sweep charge gate V8A permits a rapid charge rate for a sweep charge capacitor (C18 through C22) selected by INTERNAL SWEEP MILLISECONDS COARSE switch S4. Sweep discharge gate V9 permits a slow discharge of the selected sweep charge capacitor; the INTERNAL SWEEP MILLISECONDS FINE control permits adjustment of the sweep frequency (linear discharge rate of selected capacitor).

(3) The output (horizontal sweep sawtooth) of sweep discharge V9 is applied through sweep cathode follower V8B to the horizontal amplifier channel (para 4) and to sweep reset trigger V3.

Note: If sweep gate generator V4 is in the set condition when the SWEEP OPTIONS switch is operated from AUTO to TRIGGERED, there will be no output trigger from sweep cathode follower V8B and thus no trigger to sweep reset trigger V3. In this case, the initial reset trigger to V4 is supplied through retrace trigger V1B by sweep reset DS6. After the initial reset trigger, sweep reset DS6 becomes inactive and the horizontal sweep section functions as in (1), (2), and (3) above.

(4) The output of sweep gate generator V4 is also applied as an unblanking voltage input to retrace blanking gate V7B (para 7).

c. FREE Position of SWEEP OPTIONS Switch. When the SWEEP OPTIONS switch is at FREE, the horizontal sweep section functions as in *b* above, except that sweep gate generator V4 works as a monostable and the set trigger output from sync gate V1A is not required. The horizontal sweep is unsynchronized when the SWEEP OPTIONS switch is at FREE.

6. Sync Section

(fig. 23)

In general, the sync section is used to synchronize the operation of sweep gate generator V4 with the vertical input. The function of the sync section depends on the setting of the SWEEP OPTIONS and the CHARACTER BLANKING SELECT switches. Sync gate V1A provides a set trigger (synchronizing) pulse to sweep gate generator V4 and to blanking delay V2.

Note: When the SWEEP OPTIONS switch is at FREE, the OS-119/GGM generates an unsynchronized horizontal sweep voltage and sync gate V1A is cut off. Blanking delay V2 and the CHARACTER BLANKING SELECT switch are covered in paragraph 7.

a. AUTO Position of SWEEP OPTIONS Switch.

(1) The character sync input from the TS-1512/GGM to sync gate V1A is used to synchronize the unblanking of the crt with the vertical input (loop signal being analyzed by the

TS-1512/GGM). The leading edge of the character sync input (positive going) is synchronized with the stop-mark to start-space transition of each character (fig. 1) as is the horizontal input (para 4).

(2) The output of sync gate V1A is applied as the set trigger pulse to sweep gate generator V4; the output of V4, in turn, is applied to retrace blanking gate V7B (para 7).

(3) The output of sync gate V1A can also be applied to blanking delay V2 (para 7*b*).

b. TRIGGERED Position of SWEEP OPTIONS Switch. The transition sync input from the TS-1512/GGM to sync gate V1A is used to synchronize the internally generated horizontal sweep and the unblanking of the crt with the transition (of the loop input signal) selected for analysis by the TS-1512/GGM. The leading edge of the transition sync input (positive going) occurs one-half bit before the start of the transition selected for analysis. The output of sync gate V1A is applied as in *a*(2) and (3) above.

7. Retrace, Character Blanking, and Sweep Intensification Section (fig. 23)

a. Retrace Blanking Gate V7B. The output of sweep gate generator V4 (para 5*b*) is applied to retrace blanking gate V7B. The output of retrace blanking gate V7B is applied through regulator V13 to the control grid of the crt as a blanking voltage. When CHARACTER BLANKING SELECT switch S2 is at OFF, the blanking voltage is timed to blank the horizontal sweep only during retrace time.

b. Blanking Delay V2. Blanking delay V2 permits the crt to be blanked between character displays. When CHARACTER BLANKING SELECT switch S2 is at AUTO, blanking delay V2 is monostable; during its unstable period, the character sync or transition sync inputs are prevented from triggering sync gate V1A (para 6*b* and *c*). Time intervals up to approximately 3 seconds can be obtained by adjusting CHARACTER BLANKING ADJUST control R8. When CHARACTER BLANKING SELECT switch S2 is at manual, blanking delay V2 is bistable and a single character is displayed on the crt each time the SINGLE SWEEP RELEASE pushbutton (S3) is pressed and released.

c. Intensity Gate V7A. The intensity input pulses from the TS-1512/GGM correspond to the bit selected for analysis and to each measured transition of the vertical input signal. When INTENSITY MARKERS switch S6 is at ON and SWEEP OPTIONS switch S1 is at AUTO or TRIGGERED, the intensity input pulses are applied to intensity gate V7A. The output of intensity gate V7A is applied to regulator V13 to intensify the crt display during the bit and transition selected. The intensity input pulses can be inhibited by operating INTENSITY MARKERS switch S6 to OFF.

8. Indicator and Power Supply Sections (fig. 23)

a. Indicator Section. Cathode-ray tube V12 permits visual observation of the data-telegraph signal inputs to the TS-1512/GGM. The functions of the crt controls are given in TM 11-6625-422-12. Regulators V13 and V14 establish reference voltages for the control grid and cathode, respectively, of the crt.

b. Power Supply Section. The power section provides all of the direct-current (dc) voltages and alternating-current (ac) filament voltages required for the operation of the electron tube and crt circuits. Transformer T1 provides isolation of the crt filament circuit.

Section II. DETAILED ANALYSIS OF SIGNAL CIRCUITS

9. Vertical Amplifier Channel (fig. 24)

The vertical amplifier channel consists of vertical cathode follower V5B and vertical deflection amplifier V6.

a. Vertical Cathode Follower V5B. The vertical input signal (fig. 1) from the TS-1512/GGM is applied, through pin 14 of

connector P1, to the high-impedance input of vertical cathode follower V5B. Vertical cathode follower V5B fixes the dc level of the input signal and isolates vertical deflection amplifier V6 (*b* below) from the TS-1512/GGM circuits that generate the vertical input signal. The input signal voltage is developed across grid resistor R29. The signal from the low-impedance output of vertical cathode follower V5B is developed across cathode resistor R31 and VERTICAL BIAS potentiometer R30, and is resistively coupled to vertical deflection amplifier V6A. VERTICAL BIAS potentiometer R30 permits adjustment of the output dc level (para 29*g*) so that the position of the display on the crt does not change when VERTICAL GAIN potentiometer R33 is varied.

b. Vertical Deflection Amplifier V6. The signal from vertical cathode follower V5B (*a* above) to push-pull vertical deflection amplifier V6A is developed across the parallel combination of resistor R32 and VERTICAL GAIN potentiometer R33. VERTICAL GAIN potentiometer R33 controls the height of the display on the crt by regulating the amplitude of the input signal. Cathode bias resistor R39 provides cathode coupling between V6A and V6B. Resistors R37 and R38 are the plate loads for vertical deflection amplifiers V6A and V6B, respectively. Resistors R40 and R42 and VERTICAL CENT potentiometer R41 form a voltage divider between the +105- and -105-volt supplies. VERTICAL CENT potentiometer R41 permits vertical positioning of the display on the crt by controlling the relative dc voltage levels between the plates of V6. Filter capacitor C14 prevents transient power supply voltages from being amplified by V6B. The signal voltage developed across unbypassed cathode resistor R39 causes the amplified signal voltage at the plate of V6B to be 180° out of phase with the signal voltage at the plate of V6A, thus providing a push-pull output from the stage. The amplified outputs from V6A and V6B are directly coupled to the vertical deflection plates (pins 8 and 7, respectively, of the crt).

10. Horizontal Amplifier Channel (fig. 24)

The horizontal amplifier channel consists of horizontal cathode follower V5A, horizontal sweep amplifier V10, and horizontal deflection amplifier V11.

a. General

(1) When SWEEP OPTIONS switch S1 on the OS-119/GGM is at AUTO, a horizontal input signal (fig. 1) from the TS-1512/GGM (operating in the start-stop mode) is applied through the horizontal amplifier channel to provide the horizontal sweep on the crt (*b*, *c*, and *d* below).

(2) When SWEEP OPTIONS switch S1 is at either TRIGGERED or FREE, the OS-119/GGM generates its own horizontal sweep voltage (para 11*d*).

b. Horizontal Cathode Follower V5A. Horizontal cathode follower V5A isolates horizontal sweep amplifier V10 from the TS-1512/GGM circuits that generate the horizontal input signal. The horizontal input signal (sweep sawtooth) is applied through pin 16 of connector P1 to the high-impedance input of horizontal cathode follower V5A and is developed across grid resistor R34. The sweep sawtooth output from V5A is developed across cathode resistor R36 and HORIZONTAL BIAS potentiometer R35, and is applied through switch S1B (AUTO position) to the input circuit of push-pull horizontal sweep amplifier V10 (*c* below). HORIZONTAL BIAS potentiometer R35 permits adjustment of the output dc level (para 29*d*).

c. Horizontal Sweep Amplifier V10. The sweep sawtooth input (*b* above) to horizontal sweep amplifier V10A is developed across HORIZONTAL GAIN potentiometer R83. HORIZONTAL GAIN potentiometer R83 controls the width of the horizontal sweep line on the crt by controlling the amplitude of the sweep sawtooth voltage applied to V10A. Common cathode resistor R55 provides coupling to V10B. Resistor R53 is the plate load for V10A; resistor R54 is the plate load for V10B. Resistors

R57 and R59 and HORIZONTAL CENT potentiometer R58 form a voltage divider between the -105- and the +150-volt supplies. HORIZONTAL CENT potentiometer R58 permits the display on the crt to be positioned (horizontally) by controlling the relative dc voltage levels between the plates of V10. Resistor R56 prevents V10B from being driven to cutoff or saturation when HORIZONTAL CENT potentiometer R58 is adjusted to its extremes. Filter capacitor C23 prevents transient power supply voltages from being amplified by V10B. The sweep sawtooth voltage developed across unbypassed cathode resistor R55 causes the plate voltage variations of V10B to be 180° out of phase with the plate voltage variations of V10A, thus providing a push-pull output to horizontal deflection amplifier V11.

d. Horizontal Deflection Amplifier V11. The sweep sawtooth outputs from horizontal sweep amplifiers V10A and V10B (*c* above) are dc-coupled by resistors R60 and R63 to the grids of horizontal deflection amplifiers V11A and V11B, respectively. Resistor R64 provides cathode bias for both halves of horizontal deflection amplifier V11. Resistor R61 is the plate load for V11A; resistor R62 is the plate load for V11B. The amplified sweep sawtooth voltage outputs from V11A and V11B, which are 180° out of phase (push-pull), are applied directly to the horizontal deflection plates (pins 10 and 11, respectively) of the crt to produce the horizontal sweep.

11. Horizontal Sweep Section (fig. 24)

The horizontal sweep section includes sweep reset DS6, retrace trigger V1B, sweep gate generator V4, sweep charge gate V8A, sweep discharge V9, sweep cathode follower V8B, and sweep reset trigger V3.

a. General.

(1) When SWEEP OPTIONS switch S1 is at AUTO, the function of the horizontal sweep section is to produce a blanking voltage (gate). The blanking gate controls the operation of retrace blanking gate V7B (para 13*b*). When SWEEP OPTIONS switch S1 is at TRIGGERED or FREE, the horizontal sweep section generates both the horizontal sweep voltage and the blanking voltage.

(2) When SWEEP OPTIONS switch S1 is at AUTO, only retrace trigger V1B and sweep gate generator V4 circuits are used. The blanking input (fig. 1) from the TS-1512/GGM is applied through retrace trigger V1B to sweep gate generator V4. The blanking signal is resistance-capacitance (rc) coupled from the output of V4B to the input of retrace blanking gate V7B.

(3) When SWEEP OPTIONS switch S1 is at either TRIGGERED or FREE, all of the circuits in the horizontal sweep section are used. The horizontal sweep speeds are selected and varied by the INTERNAL SWEEP MILLISECONDS COARSE and FINE controls on the front panel of the OS-119-GGM. The output sawtooth sweep voltage is resistively coupled from the horizontal sweep section to horizontal sweep amplifier V10 (para 10*b*) through the contacts of segment Z of SWEEP OPTIONS switch S1B.

b. Sweep Reset DS6.

(1) The positive trigger voltage required to cause retrace trigger V1B to conduct is applied either from the TS-1512/GGM through pin 10 of connector P1 and coupling capacitor C2, or from sweep reset trigger V3, depending on the setting of SWEEP OPTIONS switch S1. Sweep reset trigger V3A, in turn, requires an input from sweep gate generator V4 (through sweep charge gate V8A, sweep discharge V9, and sweep cathode follower V8B). However, when SWEEP OPTIONS switch S1 is operated from AUTO to either TRIGGERED or FREE, the state of sweep gate generator V4 may be such that sweep reset trigger V3A cannot produce an output trigger pulse.

In this case, sweep reset DS6 will automatically provide the initial trigger to the grid of retrace trigger V1B. Subsequently, sweep reset DS6 becomes inactive and sweep reset trigger V3 provides all successive triggers to retrace trigger V1B.

(2) When SWEEP OPTIONS switch is operated from AUTO to either TRIGGERED or FREE, sweep reset trigger V3A is biased beyond cutoff. Capacitor C13 charges toward +150 volts through resistors R75 and R16 to the potential required to ionize sweep reset DS6. When DS6 ionizes, capacitor C13 discharges through resistor R52 and the low resistance of DS6; the voltage drop across resistor R52 (positive with respect to ground) is applied through coupling capacitor C16, diode CR5, and contacts of SWEEP OPTIONS switch S1A to the input circuit of retrace trigger V1B as the initial trigger voltage. Resistor R75 prevents capacitor C13 from charging to a potential sufficient to ionize DS6 during the time that the positive trigger from V3A is applied to V1B.

(3) Resistors R85 and R86 form a voltage divider between the -105-volt supply and ground. Diode CR5 is reversed biased by the voltage drop across resistor R85 and prevents the positive output trigger from sweep reset trigger V3 from being attenuated by the sweep reset circuit. The trigger from the plate of sweep reset trigger V3A is applied through capacitor C12 and contacts of switch S1A to the control grid of V1B. Resistor R84, in series with resistor R86 to ground, prevents loading of the trigger pulse developed across resistor R52.

c. Retrace Trigger V1B. During sweep time, retrace trigger V1B is biased beyond cutoff by the voltage drop across resistor R3 which, with resistor R4, forms a voltage divider between the -105-volt supply and ground. Capacitor C2 and resistor R3 differentiate the blanking input signal from the TS-1512/GGM. Retrace trigger V1B conducts only during the application of the positive trigger voltage (*b* above). The amplified and inverted output from V1B is developed across plate load resistor R23 which is also the plate load for sweep gate generator V4A (*d* below).

d. Sweep Gate Generator V4. Sweep gate generator V4 receives input trigger signals from retrace trigger V1B (*c* above) and sync gate V1A (para 12). The sweep gate generator functions as a bistable multivibrator ((1) below) when SWEEP OPTIONS switch S1 is at either AUTO or TRIGGERED, and as a monostable multivibrator ((2) below) when switch S1 is at FREE. The output from the sweep gate generator V4 is applied to sweep charge gate V8A (*e* below) to control the charge and discharge time of the sweep capacitor in the sweep discharge circuit (V9), and to retrace blanking gate V7B (para 13*b*(1)) to control the length of time that the crt sweep will be blanked and unblanked.

(1) *Operation as bistable.* When sweep gate generator V4 operates as a bistable multivibrator, the reset trigger is applied from retrace trigger V1B to the grid of V4B; the set trigger is applied from sync gate V1A to the grid of V4A. The input trigger voltages control the bistable operation of the multivibrator.

(a) Resistors R24, R26, and R27, and resistors R23, R25, and R28 form voltage dividers between the +250- and -105-volt supplies to establish the initial bias applied to the grid of V4A and V4B, respectively. Resistor R24 is the plate load resistor for both sync gate V1A and sweep gate generator V4B. A positive-going input signal applied to the grid of sync gate V1A increases its plate current which, in turn, increases the voltage drop across resistor R24 and decreases the plate voltage of V4B. When SWEEP OPTIONS switch S1 is at either AUTO or TRIGGERED, the negative-going

change in the plate voltage of V4B is coupled through speedup capacitor C10 to grid resistor R27, increasing the bias on V4A. The resulting positive-going change in the plate voltage of V4A is coupled through speedup capacitor C9 to grid resistor R28, decreasing the bias on V4B and further decreasing the plate voltage. The regenerative action of the the bistable circuit continues until V4A is biased beyond cutoff. The bistable will remain in this condition (V4A cut off, V4B conducting) until a reset trigger from retrace trigger V1B is applied to the grid of V4B. During this time, the crt is unblanked and there is a horizontal sweep.

(b) When a positive-going blanking input signal is applied to the OS-119/GGM, or a positive trigger is applied to V1B from DS6 or V3A, retrace trigger V1B conducts. When retrace trigger V1B conducts, the increase in current through plate load resistor R23, which is also the plate load for V4A, decreases the plate voltage V4A. The negative-going change in voltage at the plate of V4A is coupled through speedup capacitor C9 to grid resistor R28, increasing the bias on V4B. The decrease in the plate voltage of V4B is coupled through speedup capacitor C10 to grid resistor R27, decreasing the bias on V4A. The regenerative action of the circuit biases V4A at saturation and V4B at cutoff. The bistable will remain in this condition (V4A conducting, V4B cutoff) until a positive trigger ((*a*) above) is applied to the grid of V4A. During this time, the crt is blanked and the selected sweep capacitor is recharging.

(2) *Operation as monostable.* A set trigger is not required when switch S1 is at FREE, since sweep gate generator V4 operates as a monostable multivibrator and sets itself after a period of time determined by the selected circuit time constants. However, a negative-going reset trigger is supplied by retrace trigger V1B in all modes of operation.

(a) Segment Y of INTERNAL SWEEP MILLISECONDS COARSE switch S4 permits the discharge time of coupling capacitor to be changed by connecting one of resistors R76 through R80 into the grid circuit of sweep gate generator V4B. Capacitor C11, plate load resistor R23, and the grid resistor selected by switch S4 form an integrating circuit. The longer capacitor C11 discharges through the selected grid resistor, the longer tube V4B will be cut off; the crt is blanked while V4B is at cutoff.

(b) When the negative reset trigger from retrace trigger V1B (*c* above) is applied at the plate of V4A, the sudden decrease in plate voltage is coupled through capacitor C11 to the grid resistor selected by switch S4. The negative-going voltage drop across the grid resistor cuts off V4B. The high, positive voltage rise at the plate of V4B is coupled through speedup capacitor C10 to grid resistor R27 of V4A, decreasing the bias on V4A and driving the tube to saturation. When the plate voltage of V4A starts to decrease, capacitor C11 starts to discharge through the grid resistor of V4B. When the voltage drop across the selected grid resistor of V4B is no longer sufficient to keep the tube cut off, V4B will conduct. When V4B starts to conduct, the regenerative action of the circuit cuts off V4A and the multivibrator returns to its set condition.

e. Sweep Charge Gate V8A, Sweep Discharge V9, and Sweep Cathode Follower

V8B. When SWEEP OPTIONS switch S1 is at either TRIGGERED or FREE, sweep charge gate V8A, sweep discharge V9, and sweep cathode follower V8B function together to produce the horizontal sweep sawtooth voltage for the crt. These circuits are controlled by the output voltage from the sweep gate generator (*d* above). When switch S1 is at AUTO, the horizontal sweep sawtooth voltage is supplied by the TS-1512/GGM (para 10*a*).

(1) During retrace time, the positive output of sweep gate generator V4B, applied through current limiting resistor R46, permits sweep charge gate V8A to conduct. The signal at the control grid of V8A is clamped to a maximum level of +105 volts by diode CR7. Resistors R87 and R88 from a voltage divider between the +105-volt supply and ground. The lower level of the signal at the control grid of V8A is clamped at approximately +60 volts by diode CR6. When V8A conducts, it presents a low-impedance charge part to the sweep capacitor (one of capacitors C18 through C22) selected by segment Z of INTERNAL SWEEP MILLISECONDS COARSE switch S4. The selected capacitor charges rapidly through the tube. The plate of sweep discharge V9 and, therefore, the control grid of sweep cathode follower V8B are maintained at approximately +105 volts. This holds the output of V8B at a steady, positive voltage.

(2) During sweep time, the state of sweep gate generator V4 reverses and the negative-going output voltage of V4B cuts off sweep charge gate V8A. Sweep charge gate V8A appears as an open circuit in the charge path of the selected sweep capacitor (C18 through C22). The selected sweep capacitor begins discharging through INTERNAL SWEEP MILLISECONDS FINE potentiometer R51, cathode resistor R50, and the resistance of sweep discharge tube V9. Sweep discharge tube V9 acts as a constant-current discharge device, producing a linear discharge of the sweep capacitor; the discharge rate (sweep time) depends on the size of the selected sweep capacitor and the resistance of R50, R51, and V9. The linear, negative-going voltage change is applied to the grid of sweep cathode follower V8B and is reproduced in its cathode circuit ((3) below).

(3) Two parallel voltage divider networks (R21 and R22 in series, paralleled by R47 through R49 series) are in the cathode (output) circuit of sweep cathode follower V8B. The sawtooth voltage at the junction of resistors R21 and R22 is applied to sweep reset trigger V3A (*f* below). The sawtooth voltage at the variable contact of SWEEP BIAS potentiometer R48 is applied to the input of horizontal sweep amplifier V10A through rheostat R90 and SWEEP OPTIONS switch S1B.

f. Sweep Reset Trigger V3. Sweep reset trigger V3 is a Schmitt trigger circuit that generates a positive output pulse each time the negative-going sawtooth voltage input from sweep cathode follower V8B (*e*(3) above) reaches the level required to cut off V3A. The positive output pulse from V3A is applied to the input of retrace trigger V1B through capacitor C12 and segment Y of SWEEP OPTIONS switch S1A.

(1) Sweep reset triggers V3A and V3B are cathode biased by resistor R20. Grid bias is also provided for V3B by grid resistor R19 which, in conjunction with resistors R16 and R18, form a voltage divider between +150-volt and -105-volt supplies. During retrace time (sweep capacitor recharging) and most of the sweep time (sweep capacitor discharging), V3A is saturated and the voltage drop across grid resistor R19 and cathode resistor R20 is sufficient to hold V3B at cutoff. When the voltage drop across resistor R21, which is the grid resistor for V3A as

well as a cathode resistor for sweep cathode follower V8B, reaches the level required to cut off V3A, current through plate load resistor R16 decreases and the plate voltage of V3A goes highly positive. The rapid, positive voltage change at the plate of V3A is coupled through speedup capacitor C3 to grid resistor R19, and V3B goes into conduction.

(2) When the sawtooth voltage applied to the grid of V3A goes positive at the end of the sweep, the increased current flow through resistor R20 increases the bias on V3B and also lowers the plate voltage of V3A. The decrease in voltage at the plate of V3A is coupled through capacitor C3 to grid resistor R19. The bias on V3B increases and the current through plate load resistor R17 decreases until V3B is cut off and V3A is saturated. The circuit will remain in this state until the voltage across resistor R21 again reaches the level required to cut off V3A and terminate the next sweep.

12. Sync Section

(fig. 24)

The sync section includes sync gate V1A and its associated circuitry. Sync gate V1A sets sweep gate generator V4 (para 11*d* (1)(*b*)) and, depending on the setting of CHARACTER BLANKING SELECT switch S2, also sets blanking delay V2 (para 13).

a. When SWEEP OPTIONS switch S1 is at AUTO, the character sync input (fig. 1) is used to gate V1A; when switch S1 is at TRIGGERED, the transition sync input is used.

b. When switch S1 is at FREE, sync gate V1A is cut off and the OS-119/GGM generates an unsynchronized sweep voltage.

c. Resistors R1 and R5 and rheostat R2 form a voltage divider between the -105- and +150-volt supplies. Sync gate V1A is held at cutoff (*b* above) by the voltage drop across rheostat R2.

d. The positive-going input pulse (*a* above) is applied through pin 7 of connector P1, contacts 1 and 2 of SWEEP OPTIONS switch S1 (S1A, segment X), and through differentiating capacitor C1 and rheostat R2 to the grid of V1A. Resistor R24 is the plate load for both V1A and sweep gate generator V4B. The input pulse causes V1A to conduct, increasing current through resistor R24. The resulting drop in voltage at the plate of sweep gate generator V4B cuts off V4A, thus setting sweep gate generator V4.

e. When CHARACTER BLANKING SELECT switch S2 is at either AUTO or MANUAL (blanking delay circuit operating (para 13*a*)), the negative-going output from sync gate V1A cuts off blanking delay V2B. The resulting negative-going plate voltage output from V2A, applied through grid resistor R1, inhibits the positive-going input to sync gate V1A for a selected period of time. Rheostat R2 adjusts the dc level of the inhibiting voltage from blanking delay V2A (para 29*c*). The level of the inhibiting voltage must be such that the input pulse does not bring sync gate V1A out of cutoff until the inhibiting voltage goes highly positive (V2A cuts off).

13. Retrace, Character Blanking, and Sweep Intensification Section

(fig. 24)

The retrace, character blanking, and sweep intensification section includes blanking delay V2, retrace blanking gate V7B, and intensity gate V7A.

a. Blanking Delay V2. Blanking delay V2 permits the display on the crt screen to be blanked for time intervals up to 3 seconds, determined by the setting of CHARACTER BLANKING ADJUST rheostat R8, when CHARACTER BLANKING SELECT switch S2 is at AUTO. When switch S2 is at MANUAL, a single character is displayed on the crt screen each time SINGLE SWEEP RELEASE pushbutton switch S3 is depressed.

(1) Blanking delay V2 functions as a monostable multivibrator when CHARACTER BLANKING SELECT switch S2 is at AUTO, and as a bistable multivibrator when switch S2 is at MANUAL.

(a) When switch S2 is set at AUTO, the change in plate voltage of V2A is applied through coupling capacitor C4 to grid resistor R7 in series with CHARACTER BLANKING ADJUST rheostat R8. When the position of the wiper arm on rheostat R8 is changed, the discharge time of coupling capacitor C4 varies; this in turn, varies the length of time that blanking delay V2B will be cut off. The longer V2B is cut off, the longer the plate voltage of V2A will be low and will inhibit sync gate V1A.

(b) When switch S2 is at MANUAL, the change in plate voltage of V2A is coupled through speedup capacitor C6 to grid resistor R14, with no means of varying the circuit time constants. Blanking delay V2A is saturated, V2B is cut off, and the input signal to sync gate V1A is inhibited until switch S3 is depressed.

(2) Assume that blanking delay V2A is conducting, that switch S1 is at either AUTO or TRIGGERED, that switch S2 is at AUTO, and that capacitor C4 is discharging through resistor R7 and rheostat R8 produce a decreasing negative voltage at the grid of V2B.

(a) When the voltage drop across resistor R7 becomes less than the cutoff bias value, V2B conducts. The voltage drop across plate load resistor R6 increases; the resulting drop in plate voltage is applied through capacitor C5 to grid resistor R12, and cuts off V2A. Capacitor C4 recharges through the low resistance of V2B to the new, higher voltage level at the plate of V2A. The positive-going voltage change at the plate of V2A permits sync gate V1A to be triggered by the character sync or transition sync input signal. The negative-going output voltage of V1A is applied through switch S2, to a differentiating circuit (capacitor C8 and resistor R15) in the grid circuit of V2B. Capacitor C8 discharges through resistor R15 to ground, and the negative voltage developed across resistor R15 is applied to the grid of V2B through diode CR1. The positive-going voltage change at the plate of V2B is applied to the grid of V2A and brings V2A out of cutoff. The drop in plate voltage of V2A inhibits the input signal applied to the sync gate; V1A is cut off, capacitor C4 again begins to discharge, and the cycle is repeated.

(b) With switch S1 at either AUTO or TRIGGERED and switch S2 at MANUAL, V2A conducts heavily and V2B is cut off. The low plate voltage of V2A inhibits the input signal applied to sync gate V1A and there is no display on the crt screen. Resistors R6, R10, and R12, and resistors R5, R9, and R14 form voltage dividers between the +150- and -105-volt supplies to establish the initial bias at the grids of V2A and V2B, respectively. Resistors R5 and R6 are also the plate load resistors for V2A and V2B, respectively. Capacitor C7 and resistor R13 form a differentiating circuit; capacitor C13 charges to approximately 150 volts through resistors R13 R11. When SINGLE SWEEP RELEASE switch S3 is operated, the positively charged terminal of capacitor C7 is grounded and capacitor C7 discharges through R13. The negative voltage developed across resistor R13 applied through diode CR2 to the grid of V2A, cuts off V2A. The positive-going voltage change at the plate of V2A, applied to the grid of V2B, causes V2B to conduct, and also permits sync gate V1A to be triggered by the next character sync or transition sync input

signal. The negative-going output voltage of V1A sets sweep gate generator V4 to unblank the crt for one sweep, and is also applied through switch S2 to the differentiator in the grid circuit of V2B ((*a*) above). The negative voltage developed across resistor R15 cuts off V2B. The positive-going voltage at the plate of V2B is applied to the grid of V2A; V2A comes out of cutoff and its plate voltage drops (saturation). The low plate voltage of V2A again inhibits the input signal to sync gate V1A; the crt is blanked at the completion of one sweep, and remains blanked until the next operation of SINGLE SWEEP RELEASE switch S3 and receipt of the next sync trigger.

b. Retrace Blanking Gate V7B and Intensity Gate V7A.

(1) *Retrace blanking gate V7B.* Retrace blanking gate V7B is biased beyond cutoff during sweep time. Resistors R81, R82, and R24 form a voltage divider between the -105-volt and +250-volt supplies to establish the initial bias applied to the grid of V7B. When retrace trigger V1B conducts, sweep gate generator V4A goes into conduction and V4B cuts off (para 11*d*). The high, positive voltage at the plate of V4B is applied to the grid circuit of retrace blanking gate V7B. Speedup capacitor C15 charges toward the higher positive voltage and develops a voltage drop across grid resistor R82 which brings V7B out of cutoff. The voltage at the grid of V7B is clamped at +150 volts by diode CR4. Resistors R43 and R45 form a voltage divider between the +150-volt supply and ground; R43 is also the plate load for retrace blanking gate V7B. The negative-going change in voltage at the plate of V7B is applied to regulator V13 (para 14*b*). Regulator V14 acts as a fixed-drop coupling resistance and applies the change in plate voltage of V7B to the control grid of the crt to blank the screen.

(2) *Intensity gate V7A.*

(a) The intensity gate receives negative-going intensity input pulses (fig. 1) from the TS-1512/GGM through pin 12 of connector P1, INTENSITY MARKERS switch S6, and segment Z of SWEEP OPTIONS switch S1A. The input pulses, by controlling the conduction of the intensity gate V7A, indicate the measuring point of polar and neutral telegraph signals, or intensify (for one bit in each character) any transition selected by the TS-1512/GGM.

(b) Intensity gate V7A conducts at all times; the amount of conduction depends on the signal applied to its grid. Resistor R43 is the plate load for both V7A and V7B. Rheostat R44 (INTENSITY) is adjusted (para 29*i*) to establish a reference voltage level at the cathode of V7A and at the plate of V7A, V7B, and V13. Rheostat R44 and resistor R91 form a voltage divider between the +150-volt supply and ground. When SWEEP OPTIONS switch S1 is at either AUTO or TRIGGERED, and switch S6 is at ON, a negative-going intensity pulse from the TS-1512/GGM increases the bias and decreases the plate current of V7A. The resulting positive-going change in plate voltage applied through regulator V13 decreases the bias on the control grid of the crt; the predetermined part of the crt display is intensified for the duration of the intensity input pulse. The intensity input pulse can be inhibited (selected part of each bit is not intensified) by setting either switch S6 to OFF, or switch S1 to FREE.

14. Indicator Section
(fig. 24)

The indicator section includes cathode-ray indicator V12, regulators V13 and V14, and the associated circuitry required for controlling and adjusting the display on the crt screen.

a. Cathode-Ray Indicator V12. The crt has a long-persistence screen to permit the telegraph character bits to be displayed for a relatively long period of time after the voltage that produced the display has been removed. ASTIGMATISM potentiometer R70 permits the voltage on crt grids 2 and 4 to be adjusted to correct for astigmatic distortion caused by the curvature of the crt screen. Resistors R65, R67 through R69, R71, and R72 form a voltage divider between the -2,300-volt power supply and ground to obtain the proper voltages necessary for focusing and varying the intensity of the crt display and to establish the cathode reference voltage. INTENSITY potentiometer R67 permits adjustment of the voltage between the cathode and the control grid (bias voltage). FOCUS control R69 adjusts the voltage on grid 3 so that the electron beam converges at the crt screen. Rheostat R89 (SCALE ILLUM) permits adjustment of the current through scale illumination lamps DS1 through DS4 to control their brightness.

b. Regulators V13 and V14. High-voltage regulators V13 and V14 are factory-selected in sets; V14 regulates at approximately 1,750 volts (across the tube), and V13 regulates at 1,850 volts ±50 (across the tube). BLANKING ADJUST control R66 is adjusted (para 29*h*) to supply approximately +50 volts to the plate of V14. Regulator V14 and series-dropping resistor R65 are connected across 2,350 volts (-2,300 to +50). Thus, V14 regulates at approximately 1,750 volts and produces -1,700 volts (at its cahode) which is applied to resistors R67, R68, R69, R71, and R72. Regulator V13 and series-dropping resistor R73 are connected across -2,300 volts plus the positive potential at the plate of retrace blanking gate V7B. When retrace blanking gate V7B comes out of cutoff (during retrace time) and its plate voltage drops, the negative-going voltage is applied through capacitor C17 to increase the bias and cut off the crt. When retrace blanking gate V7B cuts off (during sweep time) and its plate voltage rises, the high positive voltage decreases the bias on the crt and permits it to conduct. Resistor R74 limits the current in the crt control grid circuit.

Section III. DETAILED ANALYSIS OF POWER CIRCUITS

15. General
(fig. 24)

Input power is applied to the primary winding (terminals 1 and 2) of power transformer T2 through pins 1 and 17 of connector P1. Fuse F1 (2A SLO-BLO) is in series with the primary winding and POWER switch S5. Secondary windings 1 through 4 provide the voltage required for the operation of the dc and 6.3-volt ac output circuits (para 16 and 17).

16. Dc Output Circuits
(fig. 24)

a. Unregulated -2,300-Volt Output.

(1) The ac voltage across terminals 3 and 4 of secondary winding 1 of power transformer T2 is applied to the filament-cathode of half-wave high-voltage rectifier V15.

(2) The ac voltage across terminals 4 and 5 of secondary winding 1 of power transformer T2 is applied between the plate and cathode of high-voltage rectifier V15.

(3) Pulsating dc from the plate of high-voltage rectifier V15 is applied through an rc filter that consists of resistor R92 and capacitors C24 and C25 to load resistor R93.

(4) The unregulated -2,300-volt dc output is taken across parallel-connected load resistor R93 and filter capacitor C25.

b. Unregulated +375-Volt Output.

(1) The ac voltage across secondary winding 2 (terminals 6 and 7) of power transformer T2 is applied to the rectifier voltage-doubler circuit consisting of diodes CR8 and CR9 and capacitors C26 and C29C. Resistor R94 provides current limiting.

(2) When the ac voltage forward biases half-wave rectifier CR9, capacitor C26 charges; when CR8 is forward biased, capacitor C29C charges. The voltages developed across series-connected capacitors C26 and C29C are additive.

(3) Resistors R95 and R96 and capacitors C30A and C30C filter the +375-volt output which is taken across C30C.

c. Regulated +250- and +150-Volt Outputs.

(1) The unregulated +375 volts (*b* above) is applied through voltage-dropping resistors R97, R98, and R100 to series-connected voltage regulators V16 and V17.

(2) Resistor R99, capacitor C29A, and resistor R101 and capacitor C29B, are filters for regulators V16 and V17, respectively. The filters reduce the effects of reflected voltage changes caused by large variations in load voltage.

(3) The +250-volt output, regulated by both V16 and V17, is taken across capacitor C29A; the +150-volt output, regulated by V17, is taken across capacitor C29B.

d. Regulated +105-Volt Output.

(1) The voltage developed across capacitor C29C (*b* above) is applied through voltage-dropping resistor R102 to regulator V18.

(2) Resistor R103 and capacitor C30B filter reflected voltage changes caused by large variations in load voltage.

(3) The +105-volt output, regulated by V18 is taken across capacitor C30B.

e. Regulated -105-Volt Output.

(1) The ac voltage across secondary winding 3 (terminals 8 and 9) of power transformer T2 is applied to the rectifier voltage-doubler circuit consisting of diodes CR10 and CR11 and capacitors C27 and C31B. Resistor C27 and C31B. Resistor R104 provides current limiting.

(2) When the ac voltage forward biases half-wave recfifier CR10, capacitor C31B charges; when CR11 is forward biased, capacitor C27 charges. The voltages developed across series-connected capacitors C31B and C27 are additive.

(3) Resistors R105 and R106 and capacitors C31A and C31C filter the rectified voltage which is applied through voltage-dropping resistor R107 to regulator V19.

(4) Resistor R108 and capacitor C28 filter reflected voltage changes caused by large variations in load voltage.

(5) The -105-volt output, regulated by V19, is taken across capacitor C28.

17. Ac Output Circuit
(fig. 24)

a. The ac input voltage is stepped down by secondary winding 4 (terminals 10 and 11) of power transformer T2 to 6.3 volts ac which is applied as in *b*, *c*, and *d* below.

b. The filaments of electron tubes V1 through V11 are connected across secondary winding 4.

c. The primary winding (terminals 1 and 2) of transformer T1 is connected across secondary winding 4. The secondary winding (terminals 3 and 4) of transformer T1 provides filament voltage for the cathode-ray tube.

d. Scale illumination lamps DS1 through DS4 are connected across secondary winding 4. Resistor R89 determines the brightness of the lamps by controlling the amount of current through them.

e. Power lamp DS5 indicates when power is applied to the OS-119/GGM.

CHAPTER 2

FOURTH ECHELON MAINTENANCE

Section I. TROUBLESHOOTING

Warning: Be careful when working on the 115-volt ac line connections on or near the power supply, and near the crt. Voltages as high as 2,300 volts dc are present in the equipment. Always disconnect the extension cable (if used) from the AN/GGM-1 before working on the OS-119/GGM.

18. General Maintenance Instructions

a. Troubleshooting at the fourth echelon level includes all the techniques outlined for organizational maintenance (TM 11-6625-422-12) and any special or additional techniques required to isolate a defective part. The fourth echelon maintenance procedures are not complete in themselves, they supplement the procedures described in TM 11-6625-422-12. The systematic troubleshooting procedure, which begins with the checks that can be performed at an organizational level, must be completed by means of additional localizing and isolating techniques.

Note: Troubleshooting is normally performed while the OS-119/GGM is operating as part of Test Set, Teletypewriter AN/GGM-1.

b. If troubles in the equipment indicate that the defect is in the distribution wiring that connects P1 at the rear of the OS-119/GGM, refer to the applicable wiring diagram of the shelf adapter, equipment housing, or equipment cart (TM 11-6625-422-12).

19. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective OS-119/GGM is to sectionalize the fault. Sectionalization means tracing the fault to the major circuit responsible for abnormal operation. The second step is to localize the fault. Localization means tracing the fault to the particular stage responsible for abnormal operation. The third, and final, step is to isolate the fault to a specific defective part. Some faults, such as a burned-out resistor or an arcing or shorted transformer, can often be located by sight, smell, or hearing. The majority of faults, however, must be localized and isolated by checking voltages and resistances, and observing waveforms.

b. Sectionalization. The first step in tracing trouble is to locate the major circuit at fault by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. Erratic patterns (or no pattern) on the crt screen, tube filaments that are not lighted, or other visual signs should be noted and an atttempt made to sectionalize the fault to a particular circuit (sweep circuit, deflection amplifiers, indicator, power supply, etc).

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. Use the appropriate equipment performance checklist (TM 11-6625-422-12) as an operational test.

c. Localization and Isolation. Use the methods given in (1) through (4) below to aid in localizing and isolating trouble in the OS-119/GGM. After the trouble has been localized to a particular circuit, isolate the trouble to a specific part.

(1) *Signal tracing.* Use the procedure in paragraph 21 as a guide when performing a signal trace to localize trouble in the OS-119/GGM.

(2) *Troubleshooting chart.* Use the symptoms listed in the troubleshooting chart (para 22) as a guide when localizing trouble to a particular circuit or component part.

(3) *Voltage and resistance measurements.* Use the procedure outlined in paragraph 23 as a guide when isolating a defective part.

(4) *Intermittent troubles.* The possibility of intermittent trouble must not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Refer to the wiring diagrams (fig. 15-20 and 25) and check all wiring and connections in the OS-119/GGM.

20. Tools and Test Equipment Required

The following chart lists the tools and test equipment (with their assocaited manuals) required for troubleshooting the OS-119/GGM.

Tool or test equipment	Manual
Tool Equipment TE-123	SM 11-4-5180-S07
Multimeter TS-352(*)/U[a]	TM 11-5527
Oscilloscope AN/USM-81	TM 11-6625-219-12
Test Set, Electron Tube TV-7(*)/U[b]	TM 11-6625-274-12
Test Set, Teletypewriter AN/GGM-1	TM 11-6625-422-12

[a] Multimeter TS-352(*)/U represents Multimeters TS-352/U, TS-352A/U, or TS-352B/U.

[b] Test Set, Electron Tube TV-7(*)/U represents Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.

21. Signal Tracing Procedure

a. Arrange the AN/GGM-1 (para 20) for polar operation using the electronic relay loop (TM 11-6625-422-12).

b. Connect a patch cord between the LOW Z INPUT jack on the TS-1512/GGM and the SIGNAL OUTPUT jack on the SG-431/GGM.

c. On the TS-1512/GGM, operate the INPUT SELECT switch to POLAR and the BAUDS switch to 37.

d. Remove the operable OS-119 GGM from the AN/GGM-1 and use the extension cable to connect the defective OS-119/GGM in its place.

e. Apply power to the AN/GGM-1.

f. Use Oscilloscope AN/USM-81 to observe waveforms in the OS-119/GGM. Refer to the block diagram (fig. 23) and to the waveform diagrams (fig. 1 and 2) for normal waveforms at logical test points.

Note: Waveforms are observed with reference to chassis ground.

22. Localizing Trouble

a. General. Use the troubleshooting chart (*c* below) as a guide in localizing troubles. Depending on the nature of the operational symptoms, one or more of the procedures will be necessary. Refer to the following diagrams, as appropriate: schematic (fig. 24); wiring (fig. 25); terminal board parts location and wiring (fig. 15-20); voltage and resistance (fig. 3, 4, 5, and 21); and general parts location (fig. 6-9).

b. Use of Chart. The troubleshooting chart is designed to supplement operational checks that can be performed at an organizational level. If previous operational checks make reference to a particular item on this chart, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist for the AN/GGM-1 (TM 11-6625-422-12) and continue checking until a symptom of trouble is obtained.

Caution: **Disconnect the OS-119/GGM from its source of power before making any of the resistance and continuity checks listed in the troubleshooting chart.**

c. Troubleshooting Chart.

Item	Symptom	Probable trouble	Correction
1	POWER indicator lamp and electron tube filaments do not light when POWER switch is operated to ON.	No ac power applied to equipment.	Check power source. Check fuse F1; replace if necessary. Check wiring harness (TM-6625-422-12).

Item	Symptom	Probable trouble	Correction
		Defective POWER switch --------	Check switch S5 for proper operation.
		Defective power transformer ----	Measure resistance of T2 primary (para 24); replace transformer if necessary.
2	POWER indicator lamp does not light; equipment operates normally.	POWER indicator lamp or lamp socket XDS5 defective.	Replace POWER indicator lamp DS5. Repair or replace leads to lamp socket. Check lamp socket; replace if necessary.
3	Fuse blows when POWER switch is operated to ON.	B+ or B- circuits shorted -------	Check power supply (para 25), B+ and B- circuits for shorts.
4	Scale illumination lamps do not light.	Defective rheostat R89 ----------	Turn SCALE ILLUM. control fully clockwise. If lamps still do not light, replace R89.
5	POWER supply operates but filaments of electron tubes V1 through V12 do not light.	Defective power transformer or filament circuit wiring.	Check for defective wiring between secondary 4 of transformer T2 and the tube filaments. Measure resistance of secondary 4 of transformer T2; replace transformer if necessary.
6	Filament of cathode-ray tube does not light.	Defective cathode-ray tube ------	Check continuity of the cathode-ray tube filament (pins 1 and 14); replace cathode-ray tube (para 27) if necessary.
		Defective filament transformer --	Measure resistance of transformer T1 primary and secondary (para 24); replace transformer.
7	POWER indicator lamp lights, but cathode-ray tube screen is blank (no display) in all positions of SWEEP OPTIONS switch.	Defective cathode-ray tube ------	Check continuity of cathode-ray tube filament (pins 1 and 14); replace cathode-ray tube (para 27) if filament is open.
		Proper voltages not supplied to cathode-ray tube (defective component in indicator section or power supply).	Measure voltages and resistances at pins of cathode-ray tube socket and rubber-covered anode connector (fig. 4). When an improper voltage or resistance is indicated, check the individual components in the applicable circuit (both indicator and power supply). Replace parts as necessary. If voltages and resistances are correct, replace the cathode-ray tube.
8	Cathode-ray tube screen is blank only when SWEEP OPTIONS switch is at AUTO and TRIGGERED.	Sync gate (R2) requires adjustment.	Perform sync gate (R2) adjustment (para 29c).
9	No vertical deflection ---------	Defective vertical amplifier channel.	Replace tubes V5 and V6, one at a time. Check input and output waveforms at tube socket XV6 and XV5 to determine which stage is defective. Measure voltages and resistances at the tube socket in the defective stage; replace parts as necessary.
		No vertical input signal from TS-1512/GGM.	Check for proper waveform (fig. 1) at pin 14 of connector P1. If waveform is not present but output from the TS-1512/GGM is normal, check applicable leads in the wiring harness (TM 11-6625-422-12).

Item	Symptom	Probable trouble	Correction
10	Cathode-ray tube display cannot be positioned vertically.	Defective vertical deflection amplifier V6B.	Replace tube V6.
11	Unequal vertical expansion above and below the horizontal sweep line when VERTICAL GAIN control is turned clockwise from a full counterclockwise position.	VERTICAL BIAS potentiometer R30 requires adjustment.	Perform vertical bias adjustment (para 29*g*).
			Check for open resistor R40, R41, or R42.
12	No vertical or horizontal deflection when SWEEP OPTIONS switch S1 is at AUTO, and no vertical deflection when S1 is at TRIGGERED or FREE.	Defective electron tube V5 -------	Replace V5.
13	No horizontal sweep with SWEEP OPTIONS switch at any position.	Defective horizontal sweep amplifier or horizontal deflection amplifier.	Replace tubes V10 and V11, one at a time.
			Check input and output waveforms at tube sockets XV10 and XV11 to determine which stage is defective.
			Measure voltages and resistances at the tube socket in the defective stage. Replace parts as necessary.
14	No horizontal sweep when SWEEP OPTIONS switch is at AUTO (sweep is normal in TRIGGERED and FREE).	Defective horizontal cathode follower.	Replace tube V5.
			Measure voltages and resistances at pins 1, 2, and 3 of tube socket XV5. Replace parts as necessary.
		Defective SWEEP OPTIONS switch.	Check for continuity between the wiper of R35 and the ungrounded side of HORIZONTAL GAIN control R83, with switch S1 at AUTO.
		No horizontal input signal from TS-1512/GGM.	Check for proper waveform (fig. 1) at pin 16 of connector P1. If waveform is not present but output from the TS-1512/GGM is normal, check applicable leads in the wiring harness (TM 11-6625-422-12).
15	No horizontal sweep when SWEEP OPTIONS switch is at TRIGGERED (sweep is normal at AUTO).	No transition sync signal from TS-1512/GGM.	Check for proper waveform (fig. 1) at pin 8 of connector P1. If waveform is not present but output from the TS-1512/GGM is normal, check applicable leads in the wiring harness (TM 11-6625-422-12).
		Defective sweep cathode follower, sweep discharge, sweep charge gate, sweep reset trigger, or sweep reset circuit.	Replace tubes V3, V8, and V9, one at a time.
			Measure voltages and resistances at tube sockets XV3, XV8, and XV9 and each lead from DS6, to determine the defective stage. Check each component in the defective stage; replace parts as necessary.
		Defective SWEEP OPTIONS switch S1.	Check applicable contacts on the various switch sections used when the switch is at TRIGGERED.
16	No horizontal sweep when SWEEP OPTIONS switch is at FREE (sweep is normal at AUTO).	Defective sweep cathode follower, sweep discharge, sweep charge gate, sweep gate generator, sweep reset trigger, or sweep reset circuit.	Replace tubes V3, V8, V9, one at a time.
			Measure voltages and resistances at tube sockets XV3, XV4, XV8, XV9, and each lead from DS6, to determine the defective stage. Check each component in the defective stage; replace parts as necessary.

Item	Symptom	Probable trouble	Correction
		Defective SWEEP OPTIONS switch S1.	Check applicable contacts on the various switch sections used when the switch is at FREE.
17	Cathode-ray tube display cannot be positioned horizontally.	Defective horizontal sweep amplifier V10B or horizontal deflection amplifier V11B.	Replace tubes V10 and V11, one at a time. Check input and output waveforms of V10B and V11B to determine defective stage. Measure voltages and resistances at pins 6 and 7 of the tube socket in the defective stage. Replace parts as necessary.
18	Unequal horizontal expansion when HORIZONTAL GAIN control is turned clockwise from the fully counterclockwise position. *Note:* Operate SWEEP OPTIONS switch to AUTO, and VERTICAL GAIN control fully counterclockwise.	HORIZONTAL BIAS potentiometer R35 requires adjustment.	Perform horizontal bias adjustment (para 29*d*).
19	Same as item 18 but with SWEEP OPTIONS switch at TRIGGERED.	SWEEP BIAS potentiometer R48 requires adjustment.	Perform sweep bias adjustment (para 29*e*).
20	Horizontal sweep line changes in length when SWEEP OPTIONS switch is operated from AUTO to TRIGGERED.	Sweep amplitude rheostat R90 requires adjustment.	Perform sweep amplitude adjustment (para 29*f*).
21	Cathode-ray tube display will not periodically blank with SWEEP OPTIONS switch at either AUTO or TRIGGERED, and CHARACTER BLANKING SELECT switch at AUTO.	Defective blanking delay circuit.	Replace tube V2. Measure voltages and resistances at tube socket XV2; replace parts as necessary.
		Defective CHARACTER BLANKING SELECT switch S2.	Check contacts used when switch S2 is at AUTO.
22	Blanking duration cannot be changed when switches are as indicated in item 21.	Defective CHARACTER BLANKING ADJUST control.	Replace rheostat R8.
23	No display on cathode-ray tube when SINGLE SWEEP RELEASE pushbutton is depressed (S1 at either AUTO or TRIGGERED; S2 at MANUAL).	Defective blanking delay circuit.	Check resistors R9, R10, and R11; capacitors C5, C6, and C7; and switch S3.
		Defective CHARACTER BLANKING SELECT switch S2.	Check contacts used when switch S2 is at MANUAL.
24	Sweep retrace line is visible on cathode-ray tube screen	Defective retrace blanking gate circuit.	Replace tube V7. Check input and output waveforms at pins 6 and 7 of XV7. Measure voltages and resistaances at pins 6, 7, and 8 of XV7; replace parts as necessary.
25	No intensity markers on cathode-ray tube display with INTENSITY MARKERS switch at ON and switch S1 at either AUTO or TRIGGERED.	Defective intensity gate circuit.	Replace tube V7. Measure voltages and resistances at pins 1, 2, 3 of XV7; replace parts as necessary. Check for proper waveform (fig. 23) at the input of V7A. If signal is not present, check waveform at pin 9 or pin 10 of switch S1A, segment A. If signal is present, replace switch S1; if signal is not present, check waveform at pin 12 of connector P1. If signal is present, replace switch S6.
		No intensity input from TS-1512/GGM.	Check for proper waveform at pin 12 of connector P1. If waveform is not present but output from the TS-1512/GGM is normal, check applicable leads in the wiring harness (TM 11-6625-422-12).

Item	Symptom	Probable trouble	Correction
26	Intensity of crt display is insufficient at maximum setting of INTENSITY control (R67).	Blanking adjust potentiometer R66 requires adjustment.	Perform blanking adjustment (para 29*h*).
27	Poor contrast between bit selected by TS-1512/GGM for intensification and the rest of the cathode-ray tube display.	INTENSITY rheostat R44 requires adjustment.	Perform intensity markers adjustment (para 29*i*).
28	ASTIGMATISM control has no effect upon cathode-ray tube display.	ASTIGMATISM control is defective.	Replace potentiometer R70.
29	Marker pulses on cathode-ray tube display are too bright or too dim.	Marker pulse INTENSITY control requires readjustment.	Adjust INTENSITY rheostat R44 (para 29*i*) until brightness of marker pulses is satisfactory.
30	Intensity of display and horizontal sweep length is slightly shorter than normal.	Defective high voltage regulator.	Replace regulators V13 and V14 (a matched pair). Note the position of the red dot on V13.

23. Isolating Trouble

When trouble has been localized to a particular stage (para 22), use the following techniques to isolate the defective part.

a. Test the tube involved (TM 11-6625-422-12).

b. Use voltage and resistance measurements to isolate the defective part.

(1) Check the dc resistances of transformers (para 24) and check the power supply for shorts (para 25).

(2) Refer to the schematic diagram (fig. 24) and to the voltage and resistance diagrams (fig. 3, 4, 5, and 21) to determine the normal voltage and resistance values and compare them with the values measured.

(3) When measuring voltages, use the extension cable to connect the OS-119/GGM to the AN/GGM-1.

(4) When measuring resistances, be sure to remove power from the OS-119/GGM, disconnect the extension cable, and discharge all large capacitors.

c. When tracing circuitry, refer to the wiring diagram (fig. 25). Use the resistor and capacitor color codes (fig. 10 and 22) to determine the value of components.

24. Dc Resistance of Transformers

The dc resistances of the windings of transformers T1 and T2 are listed below. Do not remove any of the electron tubes when making the measurements.

Transformer	Terminals	Resistance (ohms)
T2	1-2	1.6
	3-4	Less than 1
	3-5	4,000
	6-7	12.4
	8-9	8.5
	10-11	Less than 1
T1	Primary	Less than 1
	Secondary	Less than 1

25. Checking Power Supply Circuits for Shorts

a. When to Check.

(1) When the repair tag indicates that the fuse burns out as soon as power is applied to the OS-119/GGM.

(2) When abnormal symptoms during operational tests or during localization procedures indicate possible power supply troubles.

(3) When the nature of the abnormal symptom is not known.

b. Preparation for Checks.

(1) Remove the OS-119/GGM from the shelf adapter or from the equipment housing, as appropriate.

(2) Disconnect the anode connector from the side of the crt, and socket XV12 from the rear of the crt (fig. 8).

(3) Remove electron tubes V1 through V11 (fig. 7 and 8).

(4) Arrange the TS-352(*)/U to measure resistance. Connect the ground test lead from the TS-352(*)/U to

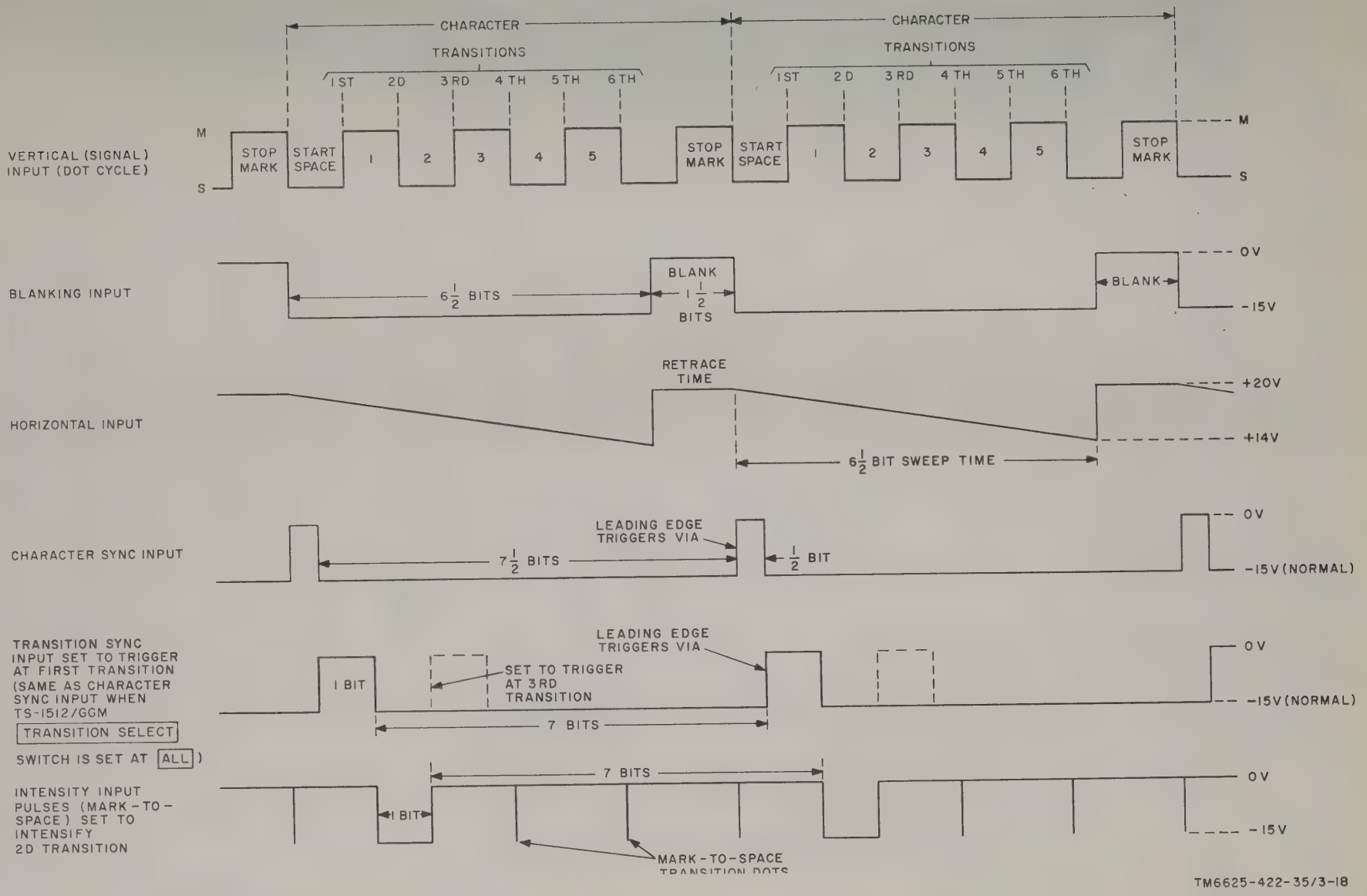


Figure 1. Input signals, waveform and voltage level diagram (dot-cycle input, seven-unit code).

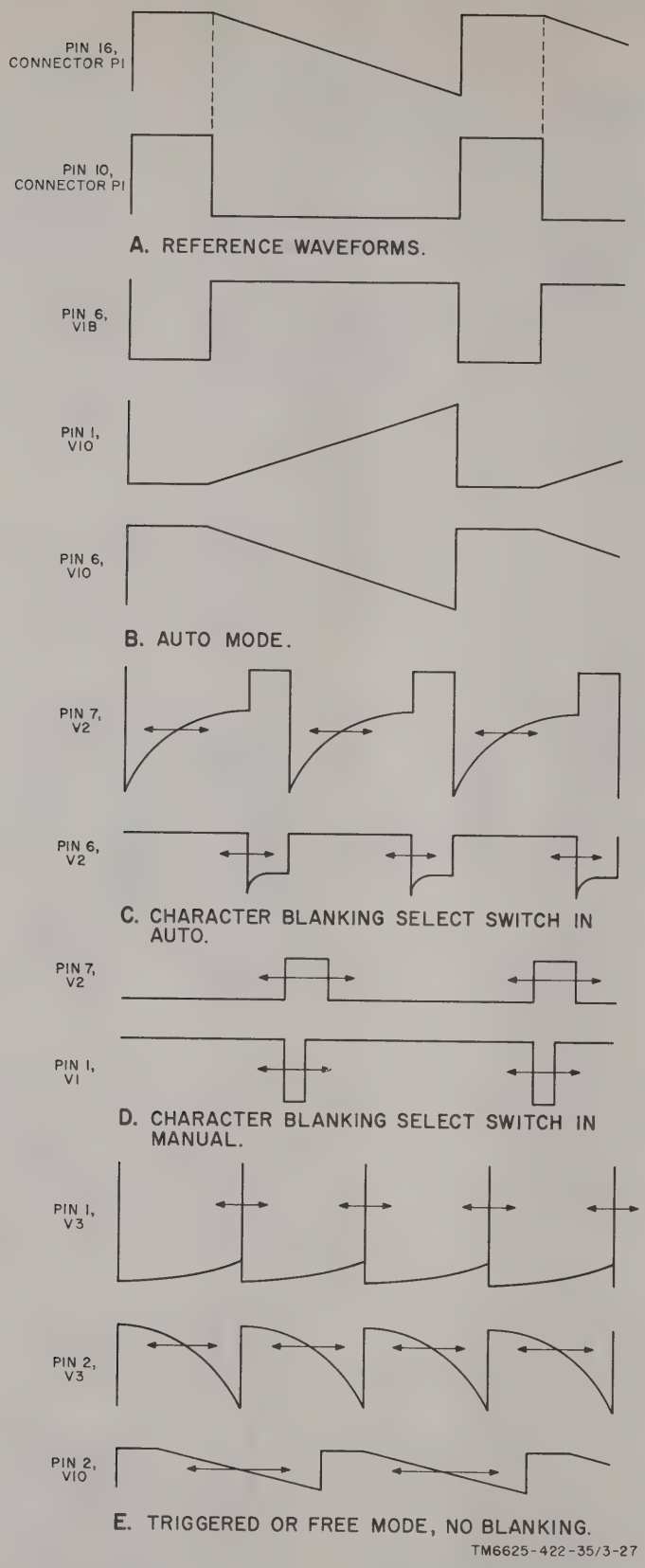


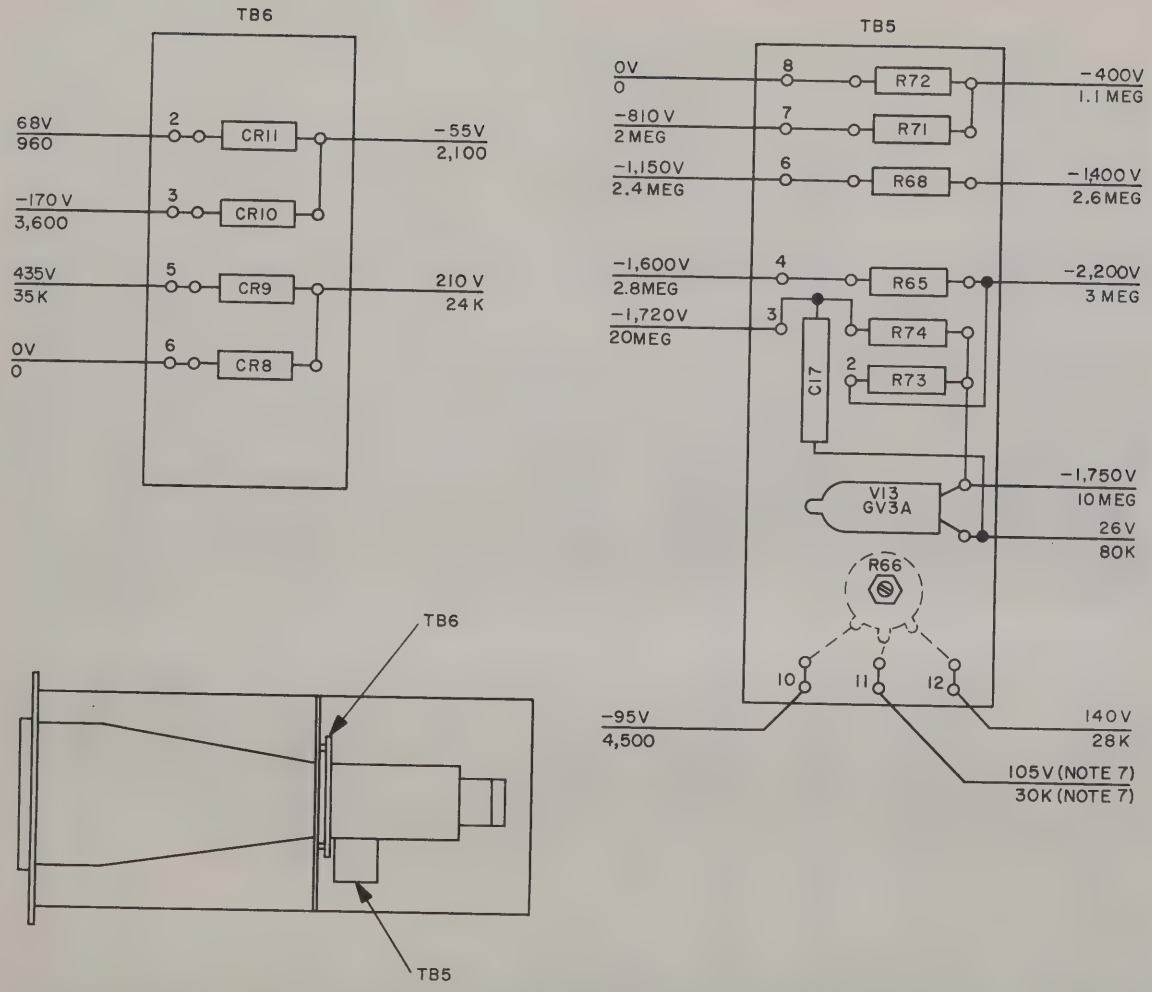
Figure 2. Waveforms for signal tracing.

either the bare strap between capacitors C24 and C25 (fig. 7) or to terminal 5 of power transformer T2.

c. Resistance Chart. Make the resistance measurements indicated in the following chart. If abnormal results are obtained (*Measured value* column), check the associated part listed in the *Probable trouble* column. When a faulty part is located, repair or replace it.

Note: After repairing the OS-119/GGM, reverse the procedures given in *b* above and perform an operational test (TM 11-6625-422-12).

Measure	Normal indication	Measured value	Probable trouble
Between terminals 1 and 2 of transformer T2 (fig. 8).	2 ohms	Less than 2 ohms	Primary of transformer T2 is shorted.
		Infinity	Primary of transformer T2 is open.
Between terminals 3 and 5 of gransformer T2.	4,000 ohms	Zero	Secondary 1 of transformer T2 is shorted.
		Infinity	Secondary 1 of transformer T2 filament cathode of V15, or their interconnecting leads are open.
Across filter capacitor C24.	3 megohms	Zero	Capacitor C24 shorted.
		100,000 ohms	Capacitor C25 shorted.
Between terminal 6 of transformer T2 and ground	28,000 ohms	55 ohms	Diode CR8 shorted.
		24,000 ohms	Diode CR9 shorted.
		13 ohms	Capacitor C29C shorted.
		1,100 ohms	Capacitor C30A shorted.
		1,400 ohms	Capacitor C30C shorted.
Between pin 1 of XV16 and ground.	18,000 ohms	220 ohms	Capacitor C29A shorted.
Between pin 1 of XV17 and ground.	21,000 ohms	220 ohms	Capacitor C29B shorted.
Between pin 1 of XV18 and ground.	4,500 ohms	220 ohms	Capacitor C30B shorted.
Between terminal 8 of transfromer T2 and ground.	2,400 ohms	1,000 ohms	Capacitor C27 shorted.
		1,100 ohms	Diode CR11 shorted.
		3,400 ohms	Diode CR10 or capacitor C31B shorted.
Between pin 2 of XV19 and ground.	4,800 ohms	220 ohms	Capacitor C28 shorted.
		900 ohms	Capacitor C31C shorted.
		1,500 ohms	Capacitor C31A shorted.
Between terminals 10 and 11 of transformer T2.	0.1 ohm	Zero	Secondary 4 of transformer T2 or primary of transformer T1 shorted.
Across the secondary of filament transformer T1.	0.3 ohm	Zero	Secondary of T1 shorted.



NOTES:

1. CONNECTIONS SHOWN ON TERMINAL BOARDS REPRESENT PRINTED WIRING.
2. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
3. ALL VOLTAGES ARE DC, MEASURED WITH A 20,000 OHMS-PER-VOLT METER.
4. ALL VOLTAGE READINGS ARE BETWEEN POINTS INDICATED AND CHASSIS GROUND.
5. ALL RESISTANCE READINGS ARE BETWEEN POINTS INDICATED AND PIN 5 OF TRANSFORMER T2.
6. MEASUREMENTS TAKEN WITH OS-119/GGM CONTROLS IN THE FOLLOWING POSITIONS, WITH NO INPUT SIGNALS:

FRONT PANEL CONTROL	POSITION
SWEEP OPTIONS	TRIGGERED
INTENSITY MARKERS	OFF
CHARACTER BLANKING SELECT	OFF
INTERNAL SWEEP MILLISECONDS COARSE	75 - 300
ALL OTHER CONTROLS	FULLY CCW

7. READING DEPENDS UPON SETTING OF R66.
8. UNLESS OTHERWISE SPECIFIED, RESISTANCES ARE IN OHMS, AND ARE MEASURED WITH EXTENSION CABLE DISCONECTED.

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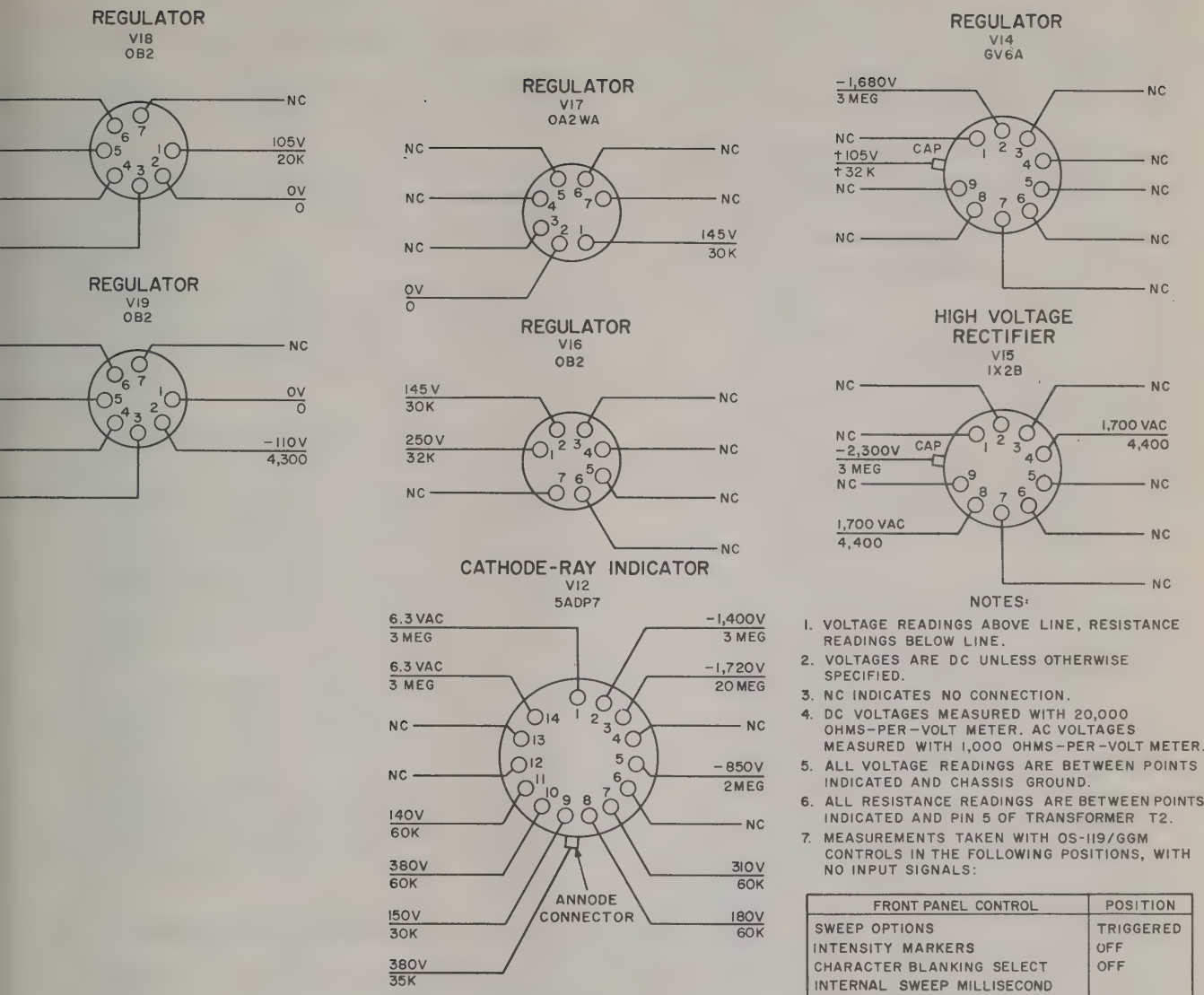
Figure 3. Terminal boards (top of chassis), voltage and resistance diagram.



NOTES:

1. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
2. VOLTAGES ARE DC UNLESS OTHERWISE SPECIFIED.
3. NC INDICATES NO CONNECTION.
4. DC VOLTAGES MEASURED WITH 20,000 OHMS-PER-VOLT METER. AC VOLTAGES MEASURED WITH 1,000 OHMS-PER-VOLT METER.
5. ALL VOLTAGE READINGS ARE BETWEEN POINTS INDICATED AND CHASSIS GROUND.
6. ALL RESISTANCE READINGS ARE BETWEEN POINTS INDICATED AND PIN 5 OF TRANSFORMER T2.
7. MEASUREMENTS TAKEN WITH OS-119/GGM CONTROLS IN THE FOLLOWING POSITIONS, WITH NO INPUT SIGNALS:

FRONT PANEL CONTROL	POSITION
SWEEP OPTIONS	TRIGGERED
INTENSITY MARKERS	OFF
CHARACTER BLANKING SELECT	OFF
INTERNAL SWEEP MILLISECOND COARSE.	75-300
ALL OTHER CONTROLS	FULLY CCW

8. † INDICATES READING DEPENDENT UPON SETTING OF R66.
9. UNLESS OTHERWISE SPECIFIED, RESISTANCES ARE IN OHMS, AND ARE MEASURED WITH EXTENSION CABLE DISCONNECTED.

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Figure 4. Tube socket voltage and resistance diagram (power supply and cathode-ray tube).

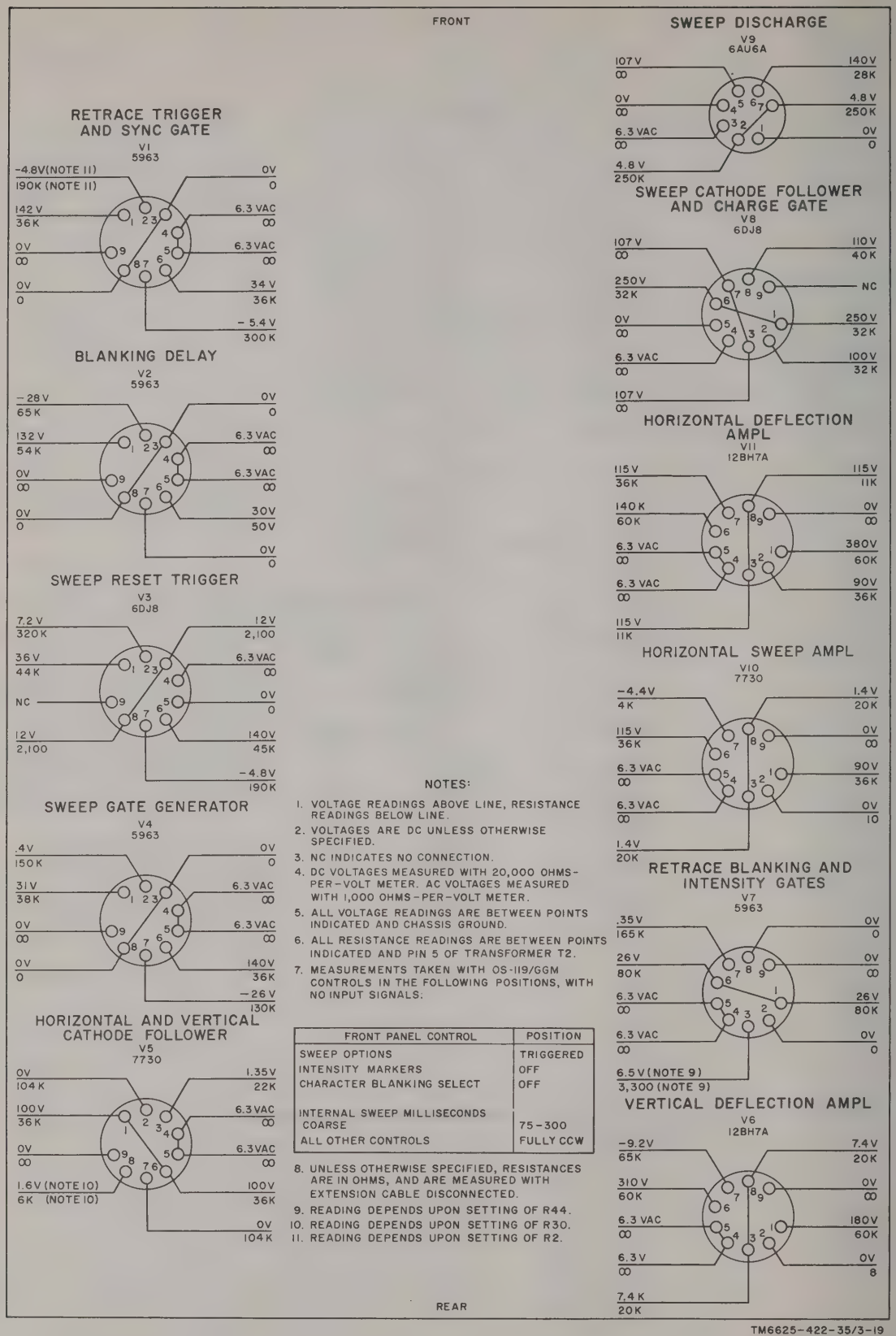


Figure 5. Tube socket voltage and resistance diagram (less power supply and cathode-ray tube).

Section II. REPAIRS AND ADJUSTMENTS

26. General Parts Replacement Techniques

Refer to *a* through *g* below, as appropriate, when replacing parts in the OS-119/GGM.

a. When a part requires replacement, tag or otherwise identify each connecting wire to avoid error when wiring the new part.

b. If potentiometer R30, R35, R48, or R66, or rheostat R2, R44, or R90 is replaced, or its setting changed, perform the appropriate adjustment procedure (para 29).

c. Regulator V17 (OA2WA) in the power supply circuit contains radioactive material. Follow the instructions given in TB SIG 225 to dispose of a defective OA2WA.

d. Follow the appropriate instructions given in TB SIG 222 to remove and replace parts and to repair the printed circuit wiring on terminal boards TB1 through TB6.

e. Follow the procedure given in paragraph 27 to replace cathode-ray tube V12.

f. Follow the procedures given in paragraph 28 to replace capacitor C24 or C25.

g. Regulators V13 and V14 are a matched pair. Replace both regulators if either one is found to be defective.

27. Replacement of Cathode-Ray Tube

Warning: **Be extremely careful when replacing the crt; do not scratch or strike the tube. Never subject the crt to more than moderate pressure during removal or replacement. Wear protective goggles or an eye-screen when handling the tube.**

a. Removal.

(1) Remove the OS-119/GGM from shelf adapter 1A or 1B or from the equipment housing, as appropriate.

(2) Remove the screws that secure the bezel to the front panel.

(3) Remove the bezel, the filter, and the engraved scale from the front panel.

(4) Remove socket XV12 (fig. 8) and the anode connector from the crt.

(5) Loosen the screw on the crt base clamp.

(6) Gently press on the screen of the crt, and slide the tube toward the rear of the magnetic shield (fig. 8).

(7) Remove the crt rubber cushion from the inside edge of the magnetic shield.

(8) Remove the crt by slowly sliding it forward through the hole in the panel.

Warning: **Do not allow the crt to strike the chassis or the front panel; do not drop the crt. Serious injury may result from flying glass.**

b. Replacement

(1) Carefully replace the crt inside the magnetic shield. Gently push the tube all the way to the rear of the shield.

(2) Position the crt rubber cushion on the inside-front edge of the magnetic shield so that the four cutouts for the scale illumination lamps are properly positioned.

(3) Place a thin coating of silicone grease on the inside of the rubber cushion.

(4) Rotate the crt so that the anode connector on the side of the crt bell is visible through the hole in the side of the magnetic shield (fig. 8).

(5) Slide the crt forward, so that the screen end of the tube rests on the rubber cushion, and the anode connector on the side of the crt bell is centered in the hole in the side of the magnetic shield.

(6) Use a clean, lint-free cloth to remove all fingerprints and foreign matter from the crt screen, the engraved scale, and the filter.

(7) Replace the engraved scale and the filter over the crt screen.

(8) Secure the bezel to the front panel.

(9) Replace the anode connector and socket XV12 on the crt.

(10) Use the extension cable to connect the OS-119/GGM to the AN/GGM-1.

(11) Connect the power cord on the AN/GGM-1 to an ac power source. Operate the equipment power

switches to ON and observe the display on the crt screen.

(12) Carefully grasp socket XV12 and gently rotate the crt until the display on its screen is aligned with the horizontal marks on the engraved scale.

(13) Tighten the screw on the crt base clamp so that the crt is secured firmly in position.

Caution: **To avoid damage to the crt, do not overtighten the base clamp screw.**

(14) Operate the equipment POWER switches to off and disconnect the

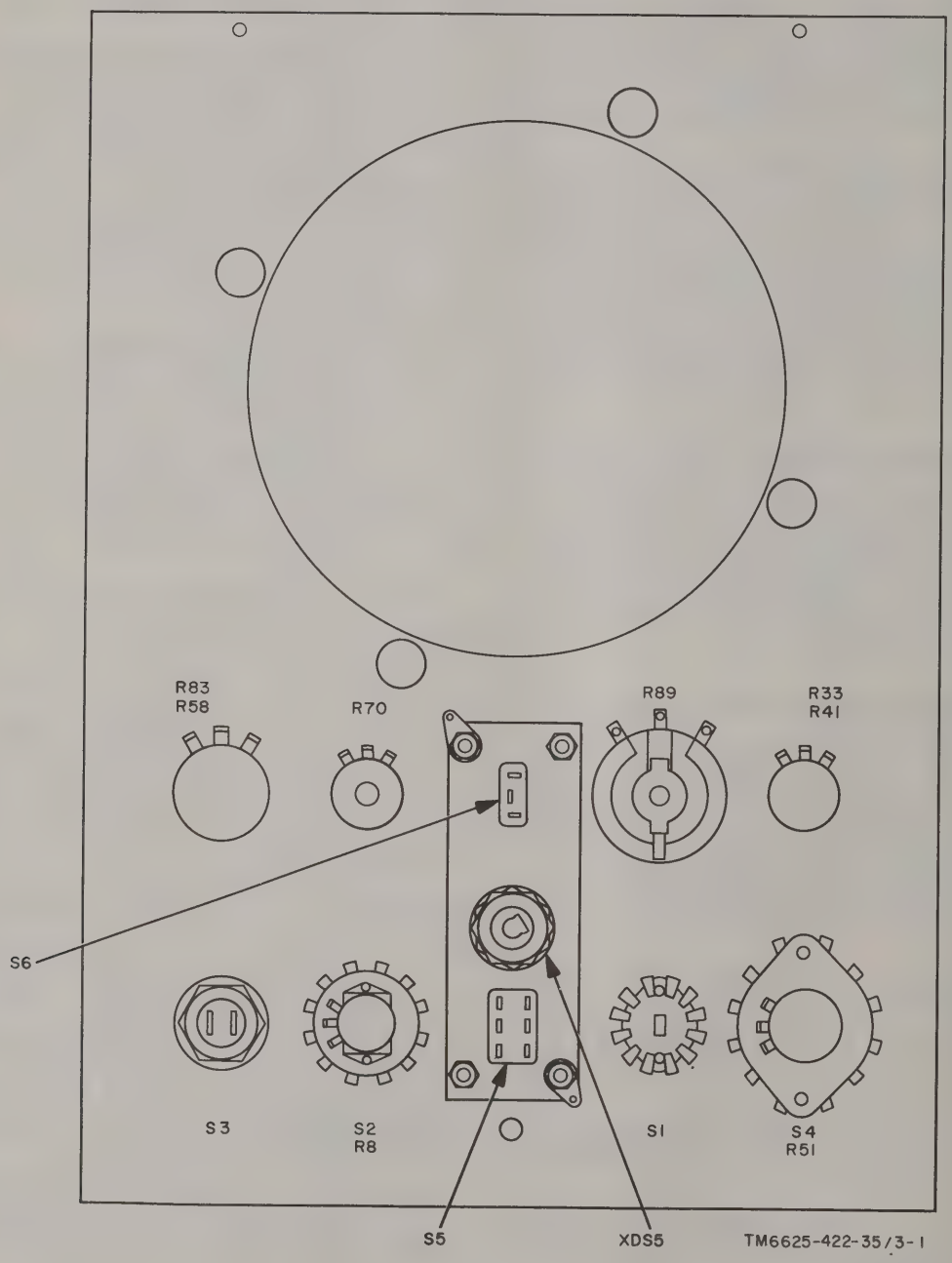


Figure 6. Oscilloscope OS-119/GGM, rear of front panel.

extension cable ((10) above); replace the OS-119/GGM, as appropriate.

28. Replacement of Capacitor C24 or C25

a. Removal.

(1) Remove electron tubes V14 through V19 (fig. 8 and 9) from the OS-119/GGM.
(2) Remove socket XV12 from the crt.
(3) Remove the cable clamp that secures the crt cable to the magnetic shield bracket.
(4) Remove the nuts, lockwashers, flat washer, spacers, and screws that secure terminal board TB5 to the magnetic shield bracket.
(5) Position the crt cable and terminal board TB5 as necessary to reach capacitors C24 and C25.
(6) Remove the nuts from the terminals of the capacitor (fig. 8) to be replaced; remove the terminal lug from each terminal of the capacitor.
(7) Loosen the nut on each capacitor clamp (fig. 7) of the capacitor to be replaced; remove one of the clamps.
(8) Remove the capacitor.

b. Replacement.

(1) Place the capacitor in position on the chassis (fig. 8).
(2) Replace the capacitor clamp (a(7) above).

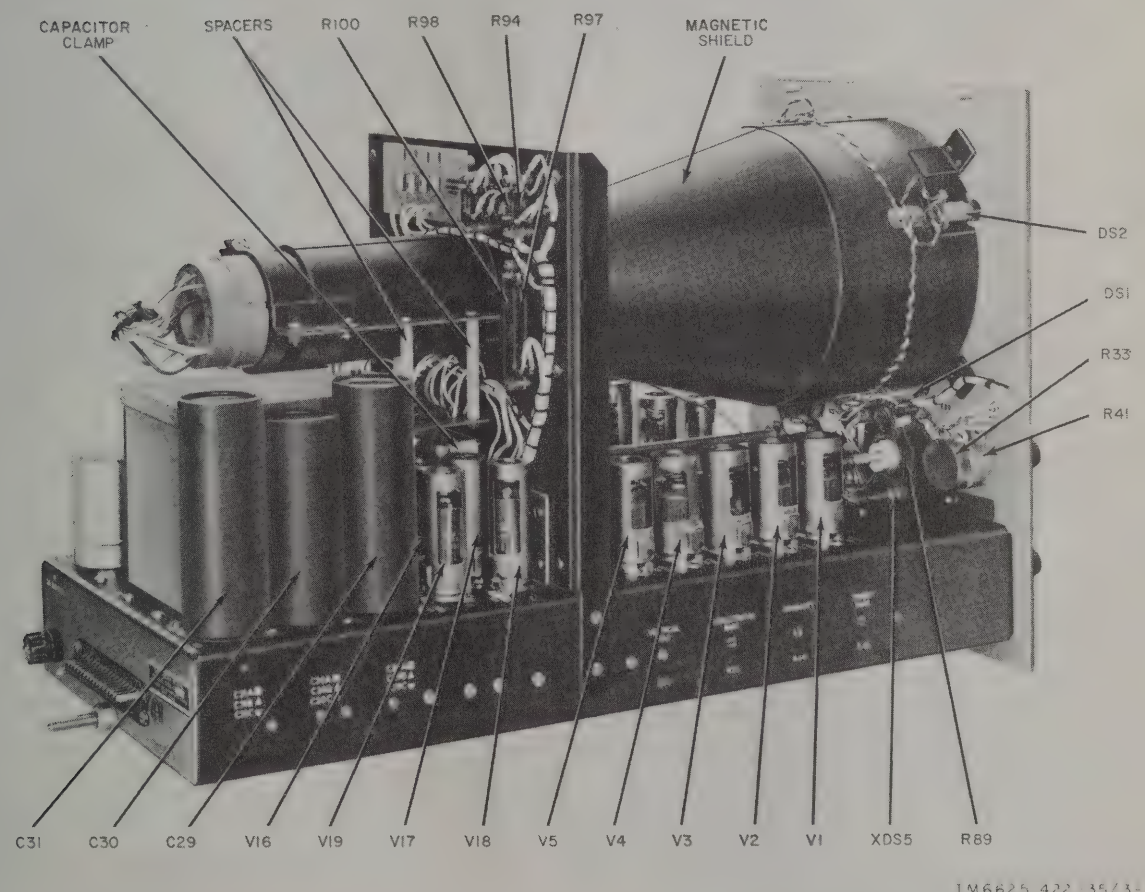


Figure 7. Oscilloscope OS-119/GGM, rear left oblique view.

(3) Tighten the nut on each clamp until the capacitor is secured to the chassis.
(4) Replace the lug on each terminal of the capacitor.
(5) Replace and tighten the nuts that secure each lug to the terminals.
(6) Replace two of the terminal board mounting screws (*a*(4) above) through the appropriate holes in the magnetic shield mounting bracket; place a spacer over each screw.
(7) Secure terminal board TB5 to the mounting screws and spacers with the flat washers, lockwashers, and nuts.
(8) Repeat the procedure given in (6) and (7) above for the other two terminal board mounting screws.
(9) Replace the cable clamp (*a*(3) above).
(10) Replace socket XV12 on the crt.
(11) Replace electron tubes V14 through V19.

29. Adjustments

Adjustment of potentiometer R30, R35, R48, or R66, or rheostat R2, R44, or R90, is required after replacing the component or as indicated by troubleshooting test results (para 22).

a. Test Equipment Required. Test Set, Teletypewriter AN/GGM-1 and Multimeter TS-352(*)/U are required for the procedures given in *b* through *i* below.

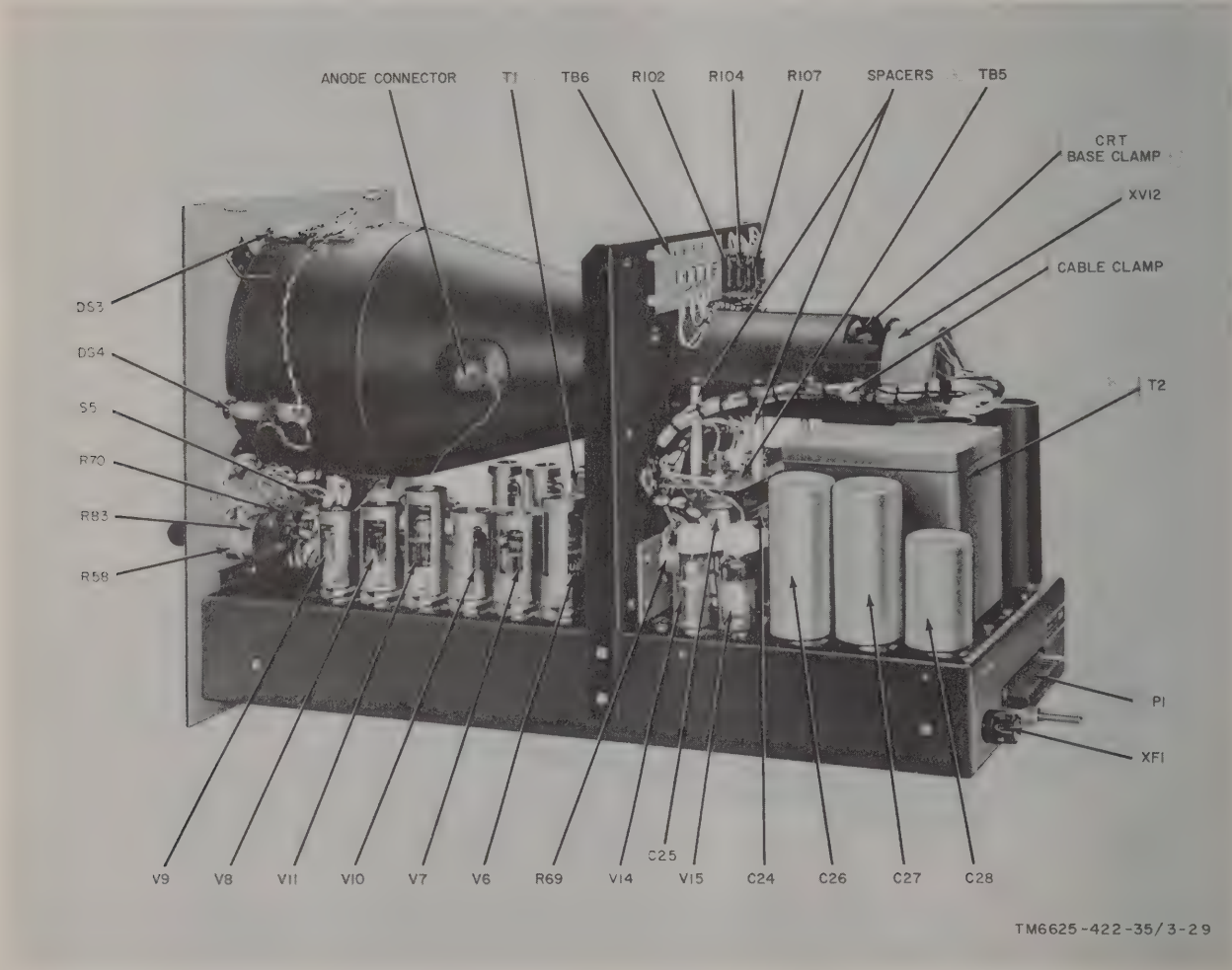


Figure 8. Oscilloscope OS-119/GGM, rear right oblique view.

b. Preliminary Procedure.

(1) Remove the operable OS-119/GMM from the AN/GGM-1 (*a* above).

(2) Use the extension cable to connect the OS-119/GGM requiring adjustment in the AN/GGM-1.

Note: Do not change the TS-1512/GGM and the SG-431/GGM controls from the positions listed in (3) and (4) below unless otherwise instructed.

(3) Operate the controls on the TS-1512/GGM as follows:

Control	Position
INPUT SELECT	POLAR, 20 OR 30 MA
SYNCHRONOUS, START-STOP	START-STOP
BAUDS	To the fixed baud rate selected on the SG-431/GGM ((4) below)
UNIT INTERVALS	7
TRANSITION SELECT:	
Left-hand switch	SPACE-MARK
Right-hand switch	ALL
DISTORTION SELECT	AVG
MAN RESET	OFF

(4) Operate the controls on the SG-431/GGM as follows:

Control	Position
DISTORTION	OFF
PERCENT DISTORTION:	
UNITS	0
TENS	0
SYNCHRONOUS, START-STOP	START-STOP
PATTERN SELECTOR	REVERSAL
CHARACTER RELEASE	FREE RUN
BAUDS	Operate to any fixed band rate

(5) Apply power to the AN/GGM-1.

Note: After the adjustments given in *c* through *i* below have been completed, remove power from the AN/GGM-1, remove the OS-119/GGM that required adjustment, and replace the original OS-119/GGM.

c. Sync Gate Adjustment (R2).

(1) Operate the OS-119/GGM controls to the following positions:

Control	Position
CHARACTER BLANKING SELECT	OFF
INTENSITY MARKERS	OFF
SWEEP OPTIONS	AUTO
HORIZONTAL CENT	Midposition
VERTICAL CENT	Midposition

(2) Arrange the TS-352(*)/U to measure negative dc voltage on the 50-volt scale and connect it between the grid (pin 2) of sync gate V1A and equipment ground.

(3) Adjust rheostat R2 (fig. 19) until the TS-352(*)/U indicates -10 volts dc.

Note: If there is no display (waveform) on the crt, slowly vary rheostat R2 to either side of the position established in (3) above until a display is observed.

(4) Use the HORIZONTAL CENT and VERTICAL CENT controls to center the display on the crt.

(5) Operate the SWEEP OPTIONS switch alternately to TRIGGERED and AUTO and slowly adjust rheostat R2 until there is a display on the crt for both positions of the switch.

d. Horizontal Bias Adjustment (R35).

(1) Operate the OS-119/GGM controls to the following positions:

Switch	Position
SWEEP OPTIONS	AUTO
CHARACTER BLANKING SELECT	OFF
VERTICAL GAIN	Fully counter-clockwise
HORIZONTAL GAIN	Fully counter-clockwise

(2) Adjust the INTENSITY control, as necessary, to avoid damaging the phosphor coating on the crt.

(3) Use the VERTICAL CENT and HORIZONTAL CENT controls to position the dot at the center of the crt screen.

(4) Adjust the FOCUS and ASTIGMATISM controls until the dot is as small and as round as possible.

(5) Adjust HORIZONTAL BIAS potentiometer R35 (fig. 9), as required, until the horizontal sweep expansion from both sides of the dot remains linear as the HORIZONTAL GAIN control is slowly turned clockwise.

(6) Adjust the HORIZONTAL GAIN control until the sweep line is expanded to the extreme vertical lines of the engraved scale.

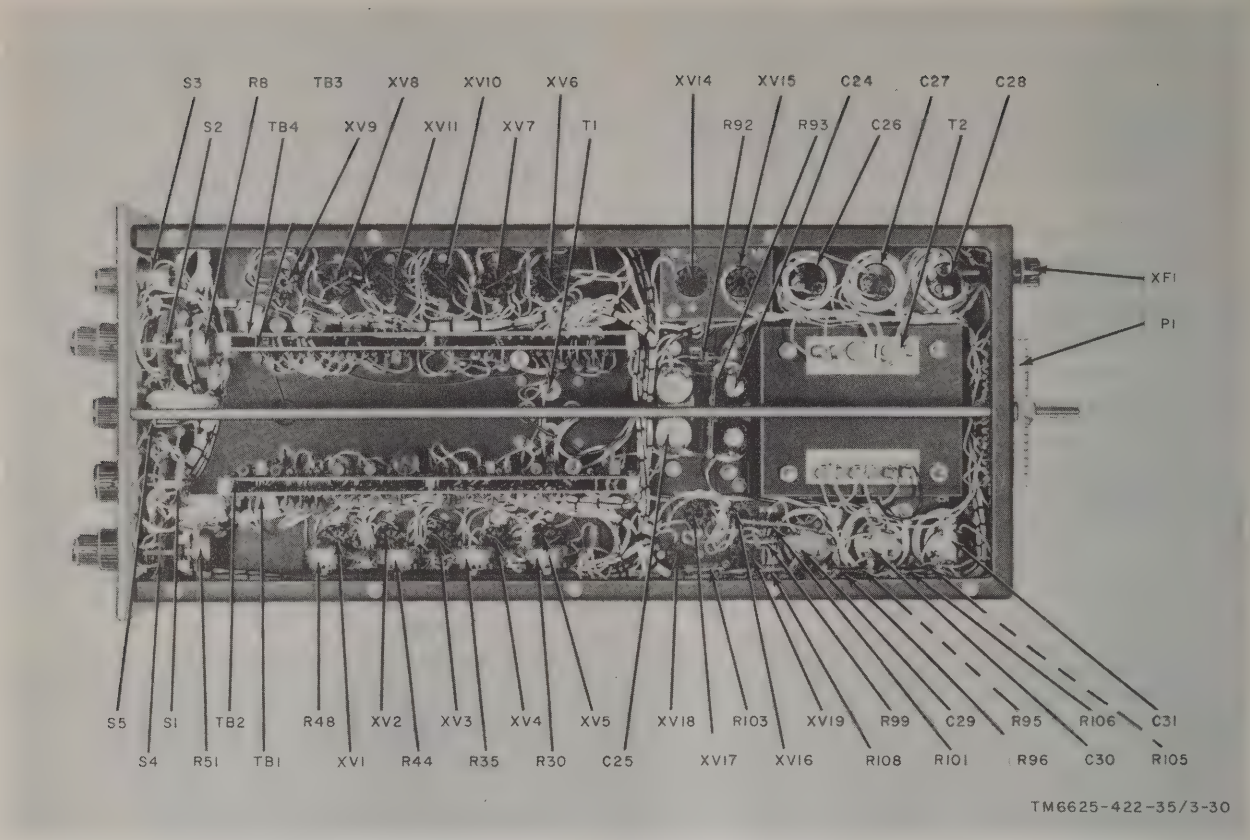


Figure 9. Oscilloscope OS-119/GGM, component location, bottom view.

e. Sweep Bias Adjustment (R48).

(1) Perform the procedures given in c(1) through (4) above; operate the SWEEP OPTIONS switch (c(1) above) to TRIGGERED.

(2) Adjust SWEEP BIAS potentiometer R48 (fig. 9), as required, until the horizontal sweep expansion from both sides of the dot on the crt screen remains linear as the HORIZONTAL GAIN control is slowly turned clockwise.

(3) Adjust the HORIZONTAL GAIN control until the sweep line is expanded to the extreme vertical lines of the engraved scale.

(4) Operate the SWEEP OPTIONS switch to AUTO. The horizontal sweep line should remain in the same position as in (3) above; if it does not, readjust potentiometer R48.

Note: If the length of the sweep line changes when the SWEEP OPTIONS switch is operated to AUTO, perform the procedure given in *f* below.

f. Sweep Amplitude Adjustment (R90).

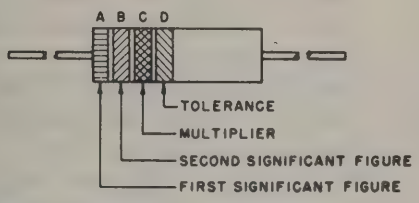
(1) Perform the procedure given in e(1), (2), and (3) above. Do not disturb the setting of the HORIZONTAL GAIN control once it has been properly adjusted.

(2) Operate the SWEEP OPTIONS switch alternately to AUTO and TRIGGERED. Adjust rheostat R90 (fig. 19) until the horizontal sweep line remains in the same position between the extreme vertical lines of the engraved scale for both positions of the SWEEP OPTIONS switch.

Note: The horizontal sweep line should remain extended between the extreme vertical lines of the engraved scale and in the same location for the AUTO and TRIGGERED positions of the SWEEP OPTIONS

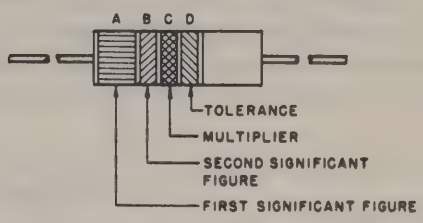
COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS

COMPOSITION-TYPE RESISTORS



BAND A— Equal Width Band Signifies Composition-Type

WIREWOUND-TYPE RESISTORS

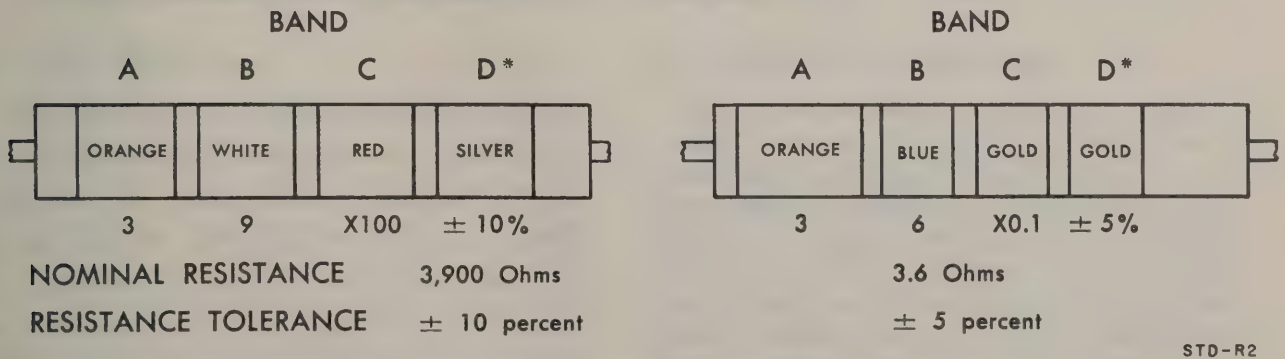


BAND A— Double Width Signifies Wire-wound Resistor

COLOR CODE TABLE

BAND A		BAND B		BAND C		BAND D*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1		
BROWN	1	BROWN	1	BROWN	10		
RED	2	RED	2	RED	100		
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	± 10
GREEN	5	GREEN	5	GREEN	100,000	GOLD	± 5
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	SILVER	0.01		
WHITE	9	WHITE	9	GOLD	0.1		

EXAMPLES OF COLOR CODING



*If Band D is omitted, the resistor tolerance is ±20%, and the resistor is not Mil-Std.

Figure 10. MIL-STD resistor color code markings.

switch. If necessary, readjust rheostat R90 to correct the length, and potentiometer R48 (*e*(2) above) to correct the position of the horizontal sweep line.

g. Vertical Bias Adjustment (R30).

(1) Operate the OS-119/GGM controls to the following positions:

Control	Position
VERTICAL GAIN	Fully counterclockwise
SWEEP OPTIONS	AUTO
INTENSITY MARKERS	OFF
CHARACTER BLANKING SELECT	OFF

(2) Use the VERTICAL CENT control to vertically center the horizontal sweep line on the crt screen.

(3) Turn the VERTICAL GAIN control from its counterclockwise position and adjust VERTICAL BIAS potentiometer R30 (fig. 9) until the square wave on the crt screen expands equally above and below the horizontal reference line.

h. Blanking Adjustment (R66).

Warning: **Use a shorting bar to discharge capacitor C25 (fig. 8) before arranging connections to the plate cap of regulator V14 ((3) and (7) below).**

(1) Operate the OS-119/GGM controls to the following positions:

Control	Position
POWER	Off (down)
INTENSITY	Fully clockwise

(2) Remove the plate cap connector from regulator V14.

(3) Arrange the TS-352(*)/U to measure direct current on the 2.5-milliampere scale. Connect the lead from the OHMS-DC ±AC jack to the plate cap of regulator V14, and the lead from the +DC CURRENT jack to the center terminal of potentiometer R66 (fig. 16).

Caution: **Observe polarity and make sure that the plate cap connector and the TS-352(*)/U leads are isolated from the chassis.**

(4) Operate the POWER switch to ON.

(5) Adjust the potentiometer R66 for an indication of 0.5 milliampere on the TS-352(*)/U.

(6) Operate the POWER switch to the off (down) position.

(7) Disconnect the TS-352(*)/U and replace the plate cap connector on regulator V14.

i. Intensity Markers Adjustment (R44).

(1) Arrange the TS-352(*)/U to measure dc voltage on the +10-volt scale and connect it between the cathode (pin 3) of intensity gate V7 and equipment ground.

(2) Operate the INTENSITY MARKERS switch and the POWER switch to ON, and the SWEEP OPTIONS switch to AUTO.

(3) Adjust INTENSITY rheostat R44 (fig. 9) for an indication of +6 volts on the TS-352(*)/U. If the intensity of the markers is not satisfactory, readjust R44 as necessary.

CHAPTER 3

FOURTH ECHELON TESTING PROCEDURES

30. General

a. These procedures are prepared, for use by Signal Field Maintenance Shops and Signal Service Organizations responsible for fourth echelon maintenance of signal equipment, to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired signal equipment *must* meet before it is returned to the using organization. A summary of the performance standards is given in paragraph 42.

b. Each test depends on the preceding one for certain operating procedures and, where applicable, for test equipment calibrations. Comply with the instructions preceding the body of each chart before proceeding to the chart. Perform each test in sequence. Do not vary the sequence. For each step, perform all the actions required in the *Test equipment control settings* and *Equipment under test control settings* columns; then, perform each specific test procedure and theck the results obtained against the performance standard.

31. Test Equipment

All test equipment, materials, and other equipments required to perform the testing procedures given in this section are listed in the following chart and are authorized under TA 11-17 and TA 11-100(11-17), TOE 11-158D, and TA 11-101(158D), or are repair part items of the subject equipment authorized for stockage at fourth echelon level. Specific models and types of test equipment were used to perform the fourth echelon testing procedures. If these testing procedures are performed with other models or types of the test equipment, an allowance must be made for any test connections or test results that may differ from those given in these test procedures.

Nomenclature	Federal stock No.	Reference
Multimeter TS-352(*)/U[ab]	6625-242-5023	TM 11-5527
Oscilloscope AN/USM-81	6625-701-4038	TM 11-6625-219-12
Test Set, Teletypewriter AN/GGM-1 (Data analysis center)	7740-893-1725	TM 11-6625-422-12
Transformer, Variable Power CN-16(*)/U[c]	5950-235-2086	None

[a]Multimeter TS-352/U, TS-352A/U, or TS-352B/U.
[b]Multimeter AN/URM-105 (TM 11-6625-203-12) may be used in place of Multimeter TD-352(*)/U.
[c]Transformer CN-16/U or CN-16A/U, or Transformer, Variable Power CN-16B/U.

32. Test Facilities

No special test facilities are required to perform the tests given in this procedure. All tests should be performed using 115- to 120-volt, 60-cycle, ac power. All connecting cords are part of the test equipment or the equipment under test unless otherwise indicated on an applicable illustration.

33. Modification Work Orders

The performance standards listed in paragraphs 34 through 38 assume that no modifications have been performed on the equipment. A listing of current modification work orders will be found in DA Pamphlet 310-4. If a modification work order is performed on the equipment, an allowance must be made for any test connections or test results that may differ from those given in these test procedures.

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34. Physical Tests and Inspection

a. Test Equipment and Materials. None.

b. Test Connections and Conditions.

(1) No test connections are necessary.

(2) Remove the OS-119/GGM. All checks should be made after repair has been completed.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Procedure	Performance standard
1	N/A ----------	Switches may be in any position --	*a.* Inspect the chassis and front panel for signs of physical damage, missing parts, and condition of paint. *Note:* Touchup painting is recommended instead of refinishing. *b.* Operate POWER and INTENSITY MARKERS switches to check for proper mechanical operation. *c.* Set INTERNAL SWEEP MILLISECONDS COARSE, SWEEP OPTIONS, and CHARACTER BLANKING SELECT switches fully counterclockwise. *d.* Depress and release SINGLE SWEEP RELEASE pushbutton. *e.* Inspect cathode-ray tube filter and the engraved scale for damage. *f.* Inspect cathode-ray tube screen for burned spots. *g.* Inspect for loose or missing fuseholder cap, and bent, loose, or broken guide pins near rear panel connector. *h.* Inspect for missing tube shields.	*a.* No damage or missing part should be evident. External surfaces intended to be painted do not show bare metal. Panel lettering is legible. *b.* Switches operate normally and are not loose. *c.* Index mark on switches indicate 75-300, AUTO, and OFF, respectively. *d.* A click is heard when pushbutton is depressed and again when it is released. *e.* Filter and engraved scale are not cracked or scratched. *f.* No burned spots are evident. *g.* Fuseholder cap is in place and tight; guide pins near rear panel connector are not bent, broken, or loose. *h.* Tube shields for V1 through V11, and V16 through V19, are in place.
2	N/A ----------	Switches may be in any position --	Check equipment for applicable modification work order (see DA Pamphlet 310-4 for list of MWO's.	If MWO is performed, MWO number appears on equipment.

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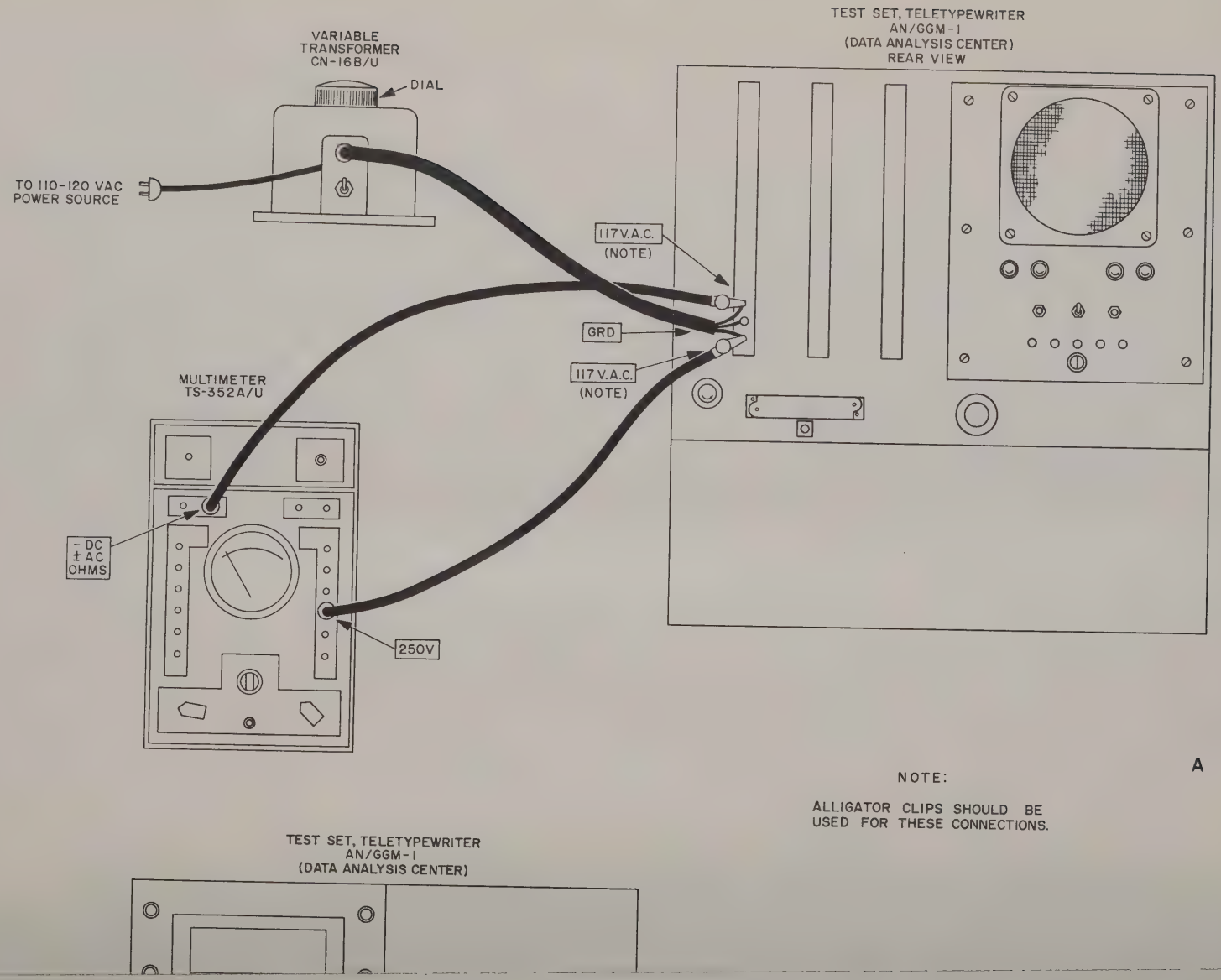


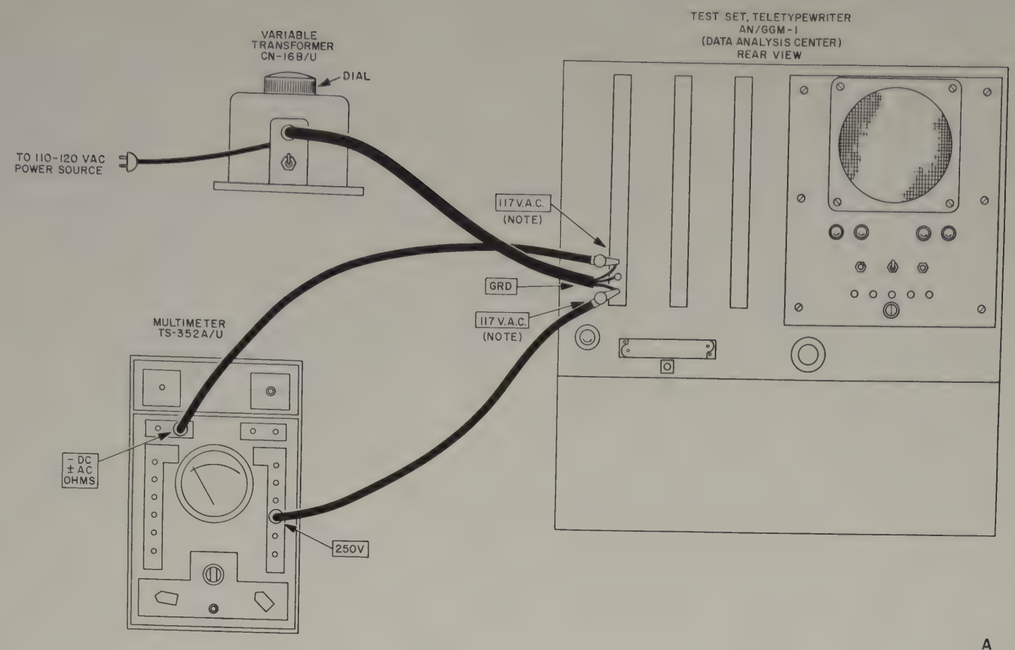
A

NOTE:

ALLIGATOR CLIPS SHOULD BE
USED FOR THESE CONNECTIONS.

TEST SET, TELETYPEWRITER
AN/GGM-1
(DATA ANALYSIS CENTER)

			C24 and C25. Disconnect end of ±DC, ±AC, OHMS test lead from OS-119/GGM and connect it to the -105-volt test point on terminal board TB4. *g.* Disconnect TS-352A/U test leads from OS-119/GGM and operate POWER switch on CN-16B/U to OFF.	*g.* None.
3	*TS-352A/U* FUNCTION selector: REV	Same as at end of step 1 -------	*Unregulated-2,300-volt* *a.* Connect equipment as shown in C, figure 11. *b.* Operate POWER switch on CN-16B/U to ON. *c.* Operate POWER switch on CN-16B/U to OFF and disconnect both TS-352A/U test leads from OS-119/GGM.	*a.* None. *b.* TS-352A/U indicates 2,300 volts ±230. *c.* None.
4	*TS-352A/U* FUNCTION selector: AC VOLTS	Same as at end of step 1 -------	*6.3-volt ac* *a.* Connect equipment as shown in D, figure 11. *b.* Operate POWER switch on CN-16B/U to OFF and disconnect TS-352A/U test leads from OS-119/GGM.	*a.* TS-352A/U indicates 6.3 volts ±1. *b.* None.



NOTE:

ALLIGATOR CLIPS SHOULD BE USED FOR THESE CONNECTIONS.

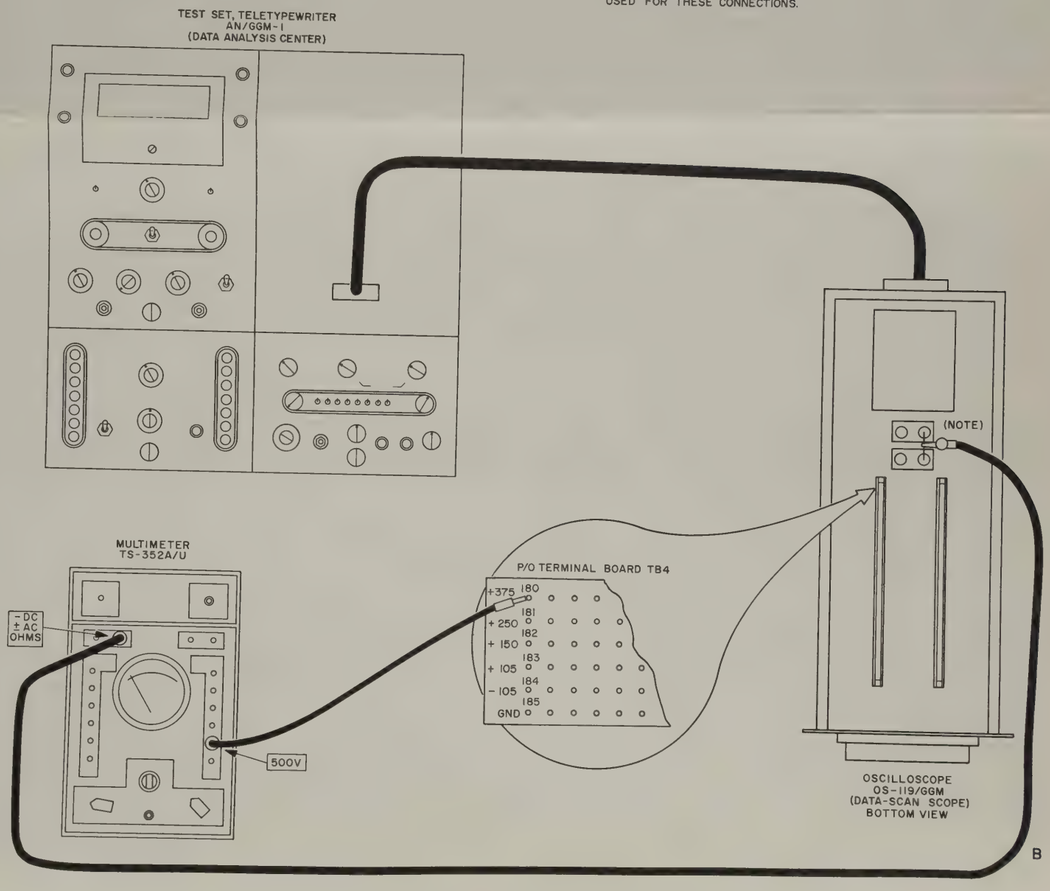
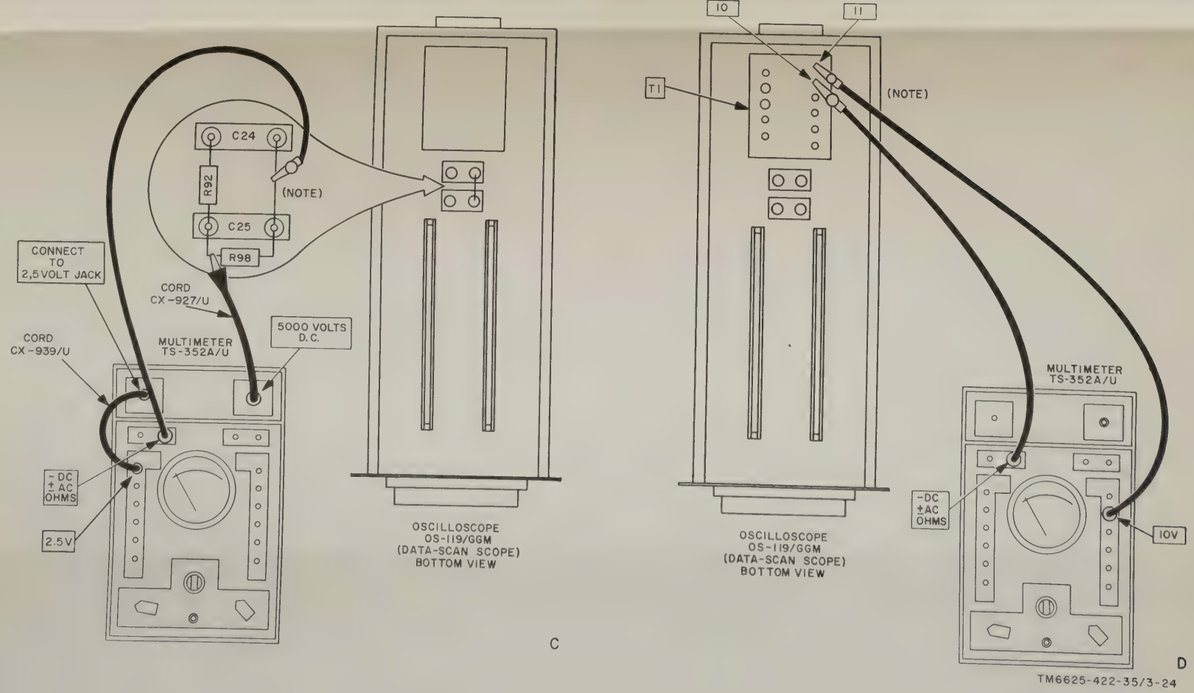


Figure 11. Test setup for power supply output voltage test.



TM6625-422-35/3-24

35. Power Supply Output Voltage Test
(fig. 11)

a. Test Equipment and Materials.
(1) Multimeter TS-352A/U.
(2) Variable Transformer CN-16B/U.
(3) Test Set, Teletypewriter AN/GGM-1 (data analysis center).
(4) Cords CX-927/U and CX-939/U (P/O TS-352A/U).

b. Test Connections and Conditions. Use the extension cable to connect the OS-119/GGM to be tested in the AN/GGM-1 and connect the equipment as shown in A, figure 11.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Procedure	Performance standard
1	*TS-352A/U.* FUNCTION selector: AC VOLTS *CN-16B/U.* Selector dial: maximum counterclockwise. POWER: ON	POWER: ON ----------	a. Adjust selector dial on CN-16B/U for an exact 117-volt indication on TS-352A/U. b. Operate POWER switch on CN-16B/U to OFF, and disconnect TS-352A/U test leads from AN/GGM-1.	a. TS-352A/U indicates 117 volts ac. b. None.
2	*TS-352A/U* FUNCTION selector: 1000Ω/VDC. *CN-16B/U* POWER: ON	Same as at end of step 1 -------	*Unregulated +375-volt* a. Connect equipment as shown in B, figure 11. *Regulated +250-volt* b. Disconnect test lead from +375-volt test point on terminal board TB4, and connect it to +250-volt test point. c. Disconnect both ends of the test lead that connects between the 500V jack on the TS-352A/U and the +250-volt test point on terminal board TB4. *Regulated +150-volt* d. Connect the test lead (c above) between the 250V jack on the TS-352A/U and the +150-volt test point on terminal board TB4. *Regulated +105-volt* e. Disconnect test lead from +150-volt test point on terminal board TB4 and connect it to +105-volt test point. *Regulated -150-volt* f. Disconnect test lead from +105-volt test point and connect it to the bare wire between capacitors C24 and C25. Disconnect end of ±DC, ±AC, OHMS test lead from OS-119/GGM and connect it to the -105-volt test point on terminal board TB4. g. Disconnect TS-352A/U test leads from OS-119/GGM and operate POWER switch on CN-16B/U to OFF.	a. Multimeter indicates 375 volts ±7.5. b. Multimeter indicates 250 volts ±12.5. c. None. d. TS-352A/U indicates 150 volts ±15. e. TS-352A/U indicates 105 volts ±5.25. f. TS-352A/U indicates 105 volts ±5.25. g. None.
3	*TS-352A/U* FUNCTION selector: REV	Same as at end of step 1 -------	*Unregulated-2,300-volt* a. Connect equipment as shown in C, figure 11. b. Operate POWER switch on CN-16B/U to ON. c. Operate POWER switch on CN-16B/U to OFF and disconnect both TS-352A/U test leads from OS-119/GGM.	a. None. b. TS-352A/U indicates 2,300 volts ±230. c. None.
4	*TS-352A/U* FUNCTION selector: AC VOLTS	Same as at end of step 1 -------	*6.3-volt ac* a. Connect equipment as shown in D, figure 11. b. Operate POWER switch on CN-16B/U to OFF and disconnect TS-352A/U test leads from OS-119/GGM.	a. TS-352A/U indicates 6.3 volts ±1. b. None.

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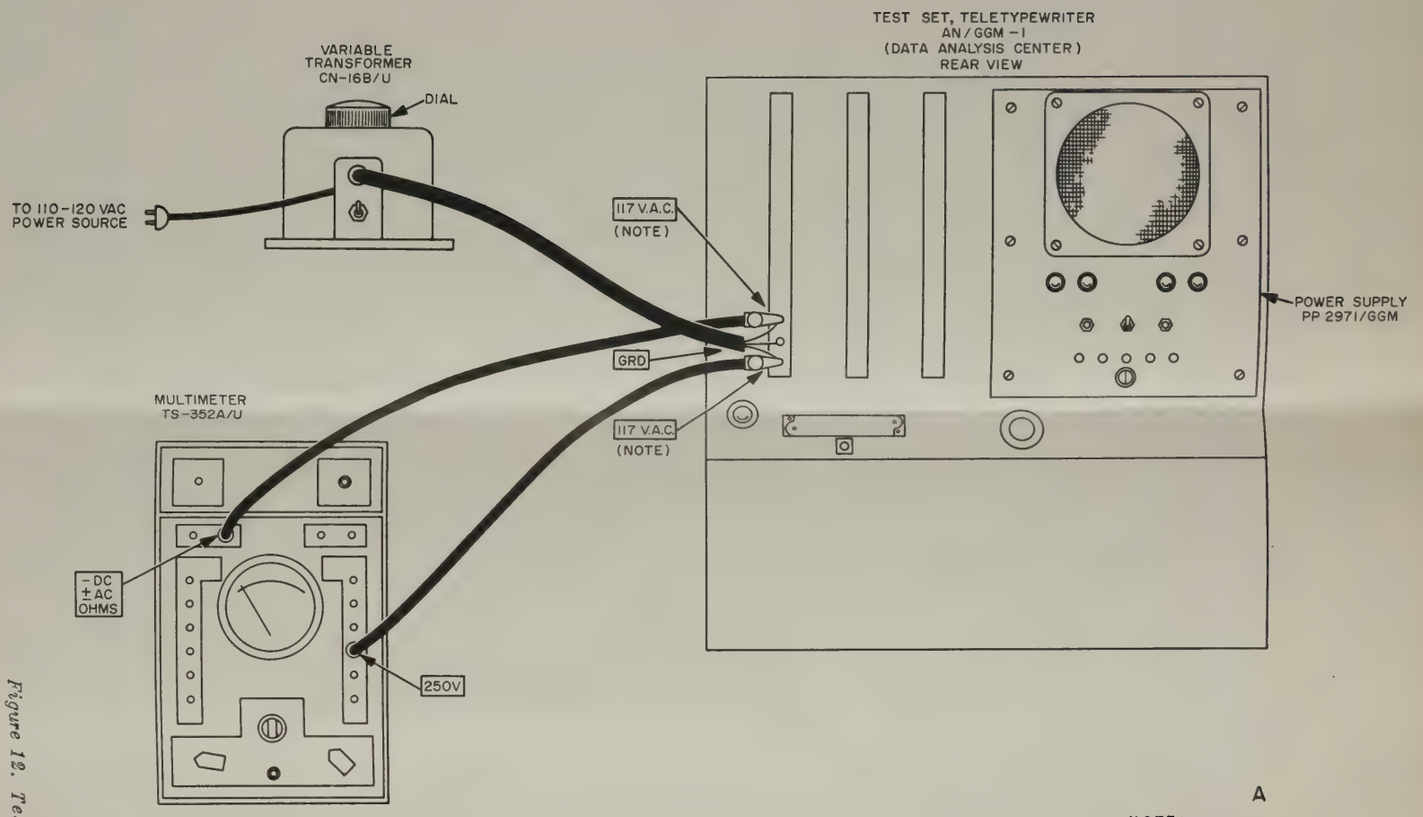


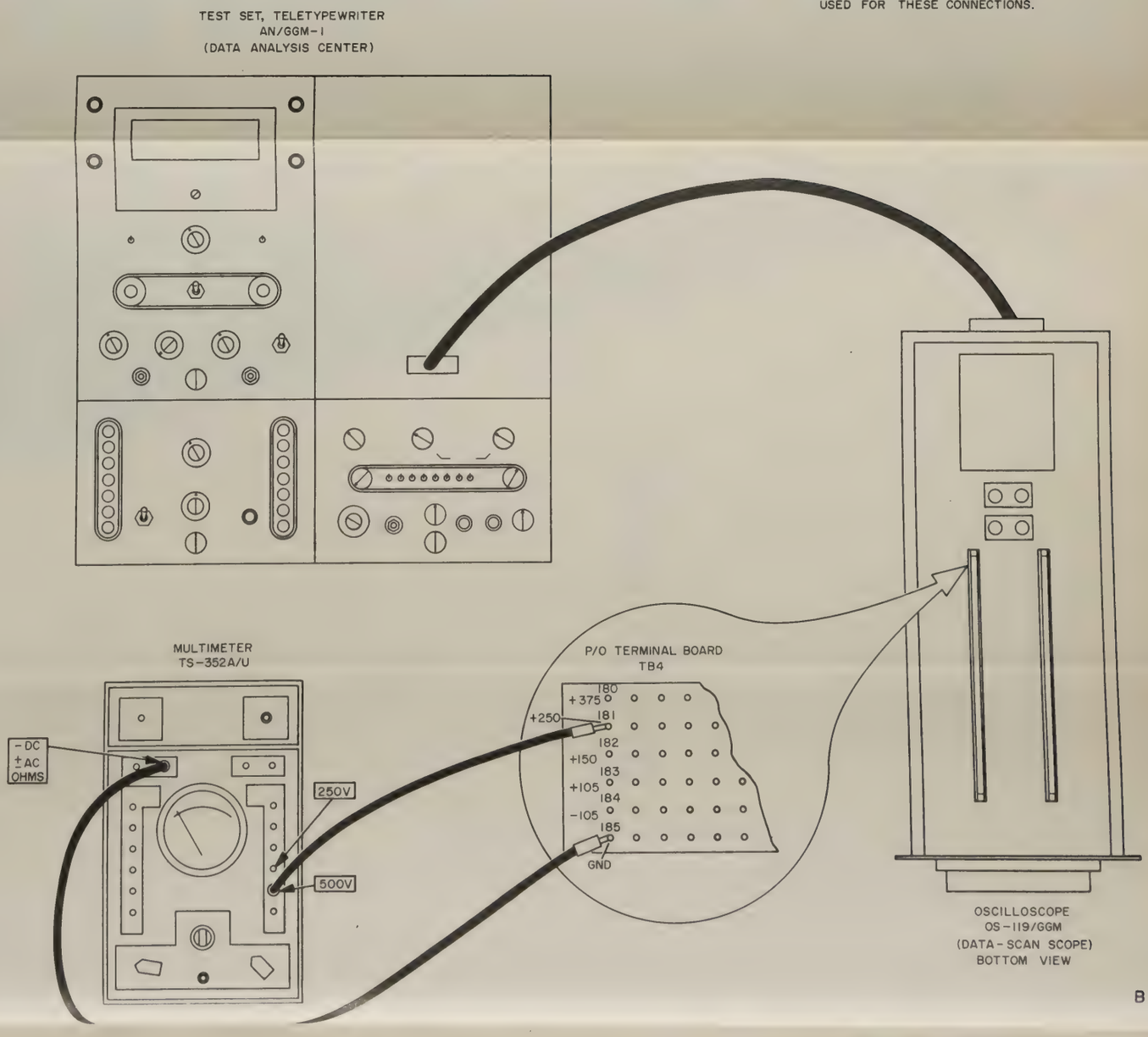
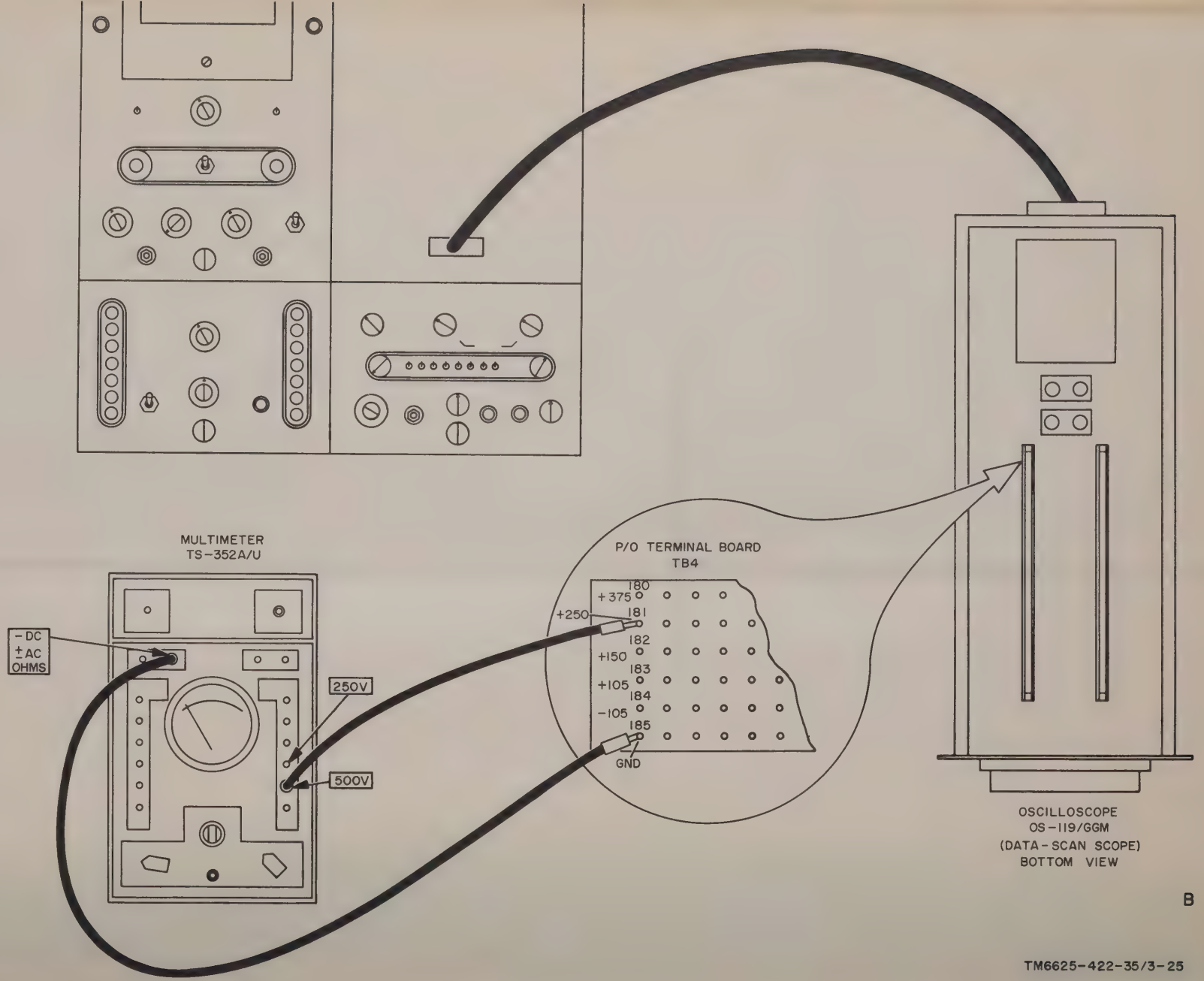


Figure 12. Test setup for percent regulation test of power supply output voltages.

gulation test of power supply output voltages.



B

			c. Disconnect test lead from +150-volt test point and connect it to +105 volt test point on terminal board TB4.	*c.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1.
			d. Rotate selector dial on CN-16B/U until TS-352A/U (A, fig. 12) indicates 128 volts.	*d.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1.
			e. Disconnect both TS-352A/U (B, fig. 12) test leads from OS-119/GGM.	*e.* None.
			Regulated -105-volt	
			f. Connect test lead from 500V jack on TS-352A/U (B, fig. 12) to GND point on terminal board TB4. Connect test lead from -DC ±AC OHMS jack on TS-352A/U (B, fig. 12) to -105-volt test point on terminal board TB4.	*f.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1.
			g. Rotate selector dial on CN-16B/U until TS-352A/U (A, fig. 12) indicates 105 volts.	*g.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1.
			h. Operate POWER switch on CN-16B/U to OFF and disconnect both TS-352A/U's from OS-119/GGM.	*h.* None.

36. Percent Regulation Test
(fig. 12)

a. Test Equipment.

(1) Multimeter TS-352A/U (2 each).
(2) Variable Transformer CN-16B/U.
(3) Test Set, Teletypewriter AN/GGM-1 (data analysis center).

b. Test Connections and Conditions. Use the extension cable to connect the OS-119/GGM to be tested in the AN/GGM-1, and connect the equipment as shown in A, figure 12. The TS-352A/U used to measure the output voltage of the CN-16B/U remains connected throughout the test.

c. Procedure.

Step No.	Test equipment control settings	Equipment under test control settings	Procedure	Performance standard
1	*TS-352A/U* FUNCTION selector: AC VOLTS *CN-16B/U* Selector dial: maximum counter-clockwise. POWER: ON	POWER: ON ----------	Adjust selector dial on CN-16B/U for an exact 117-volt indication on TS-352A/U.	TS-352A/U indicates 117 volts ac.
2	*TS-352A/U* FUNCTION selector: 1000Ω/VDC.	Same as at end of step 1 -------	*Regulated +250-volt* *a.* Connect the second TS-352A/U as shown in B, figure 12. *b.* Rotate selector dial on CN-16B/U until TS-352A/U (A, fig. 12) indicates 105 volts. *c.* Rotate selector dial on CN-16B/U until TS-352A/U (A, fig. 12) indicates 128 volts. *d.* Disconnect both ends of the test lead that connects between the 500V jack on the TS-352A/U and the +250-volt test point on terminal board TB4.	*a.* TS-352A/U (B, fig. 12) indicates 250 volts ±7.5. *b.* TS-352A/U (B, fig. 12) indicates 250 volts ±7.5. *c.* TS-352A/U (B, fig. 12) indicates 250 volts ±7.5. *d.* None.
3	Same as at end of step 2 -----	Same as at end of step 1 -------	*Regulated +150-volt* *a.* Connect the test lead removed in *d*, step 2, between the 250V jack on the TS-352A/U (B, fig. 12) and the +150-volt test point on terminal board TB4. *b.* Rotate selector dial on CN-16B/U until TS-352A/U (A, fig. 12) indicates 105 volts. *Regulated +105-volt* *c.* Disconnect test lead from +150-volt test point and connect it to +105 volt test point on terminal board TB4. *d.* Rotate selector dial on CN-16B/U until TS-352A/U (A, fig. 12) indicates 128 volts. *e.* Disconnect both TS-352A/U (B, fig. 12) test leads from OS-119/GGM. *Regulated -105-volt* *f.* Connect test lead from 500V jack on TS-352A/U (B, fig. 12) to GND point on terminal board TB4. Connect test lead from -DC ±AC OHMS jack on TS-352A/U (B, fig. 12) to -105-volt test point on terminal board TB4. *g.* Rotate selector dial on CN-16B/U until TS-352A/U (A, fig. 12) indicates 105 volts. *h.* Operate POWER switch on CN-16B/U to OFF and disconnect both TS-352A/U's from OS-119/GGM.	*a.* TS-352A/U (B, fig. 12) indicates 150 volts ±4.5. *b.* TS-352A/U (B, fig. 12) indicates 150 volts ±4.5. *c.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1. *d.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1. *e.* None. *f.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1. *g.* TS-352A/U (B, fig. 12) indicates 105 volts ±3.1. *h.* None.

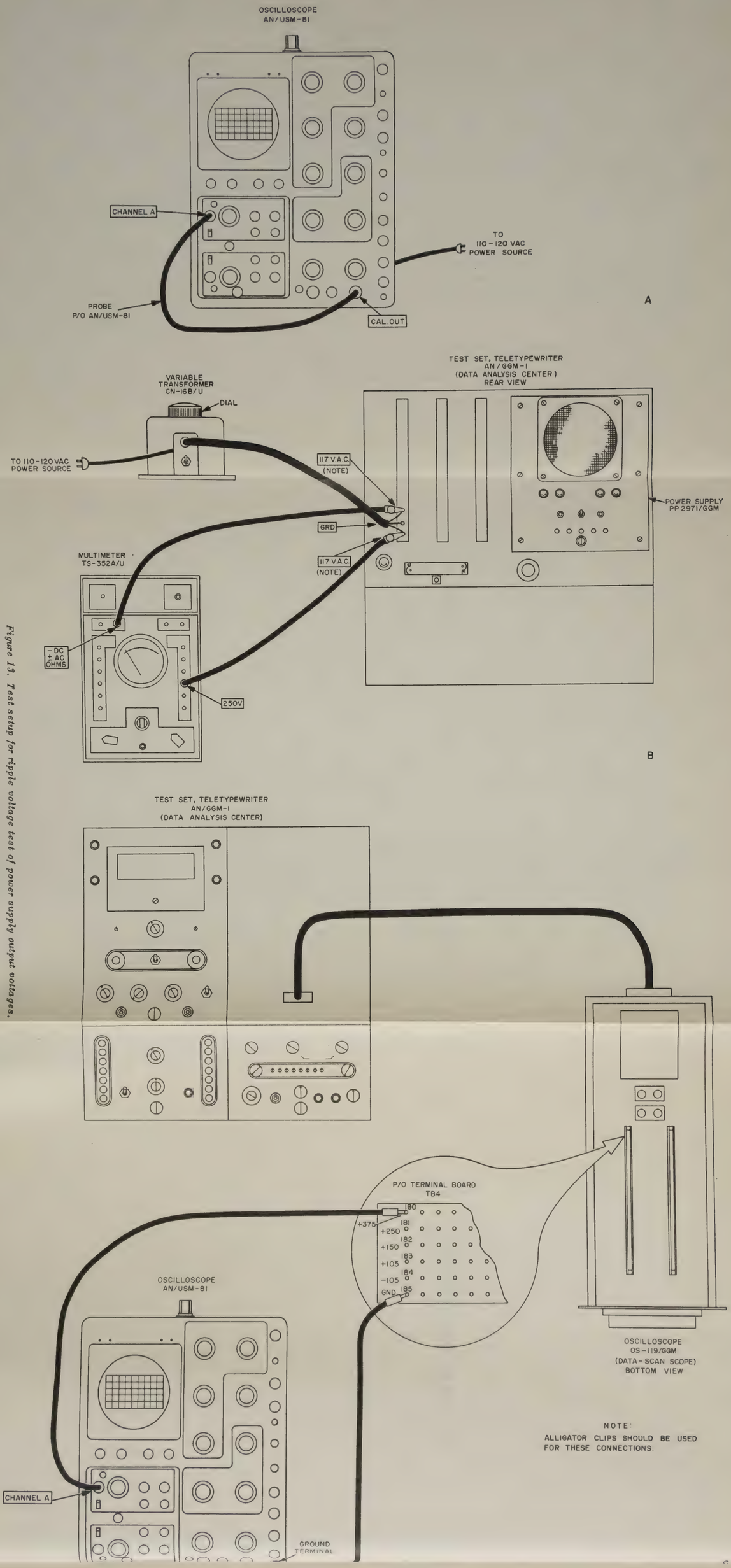


Figure 13. Test setup for ripple voltage test of power supply output voltages.

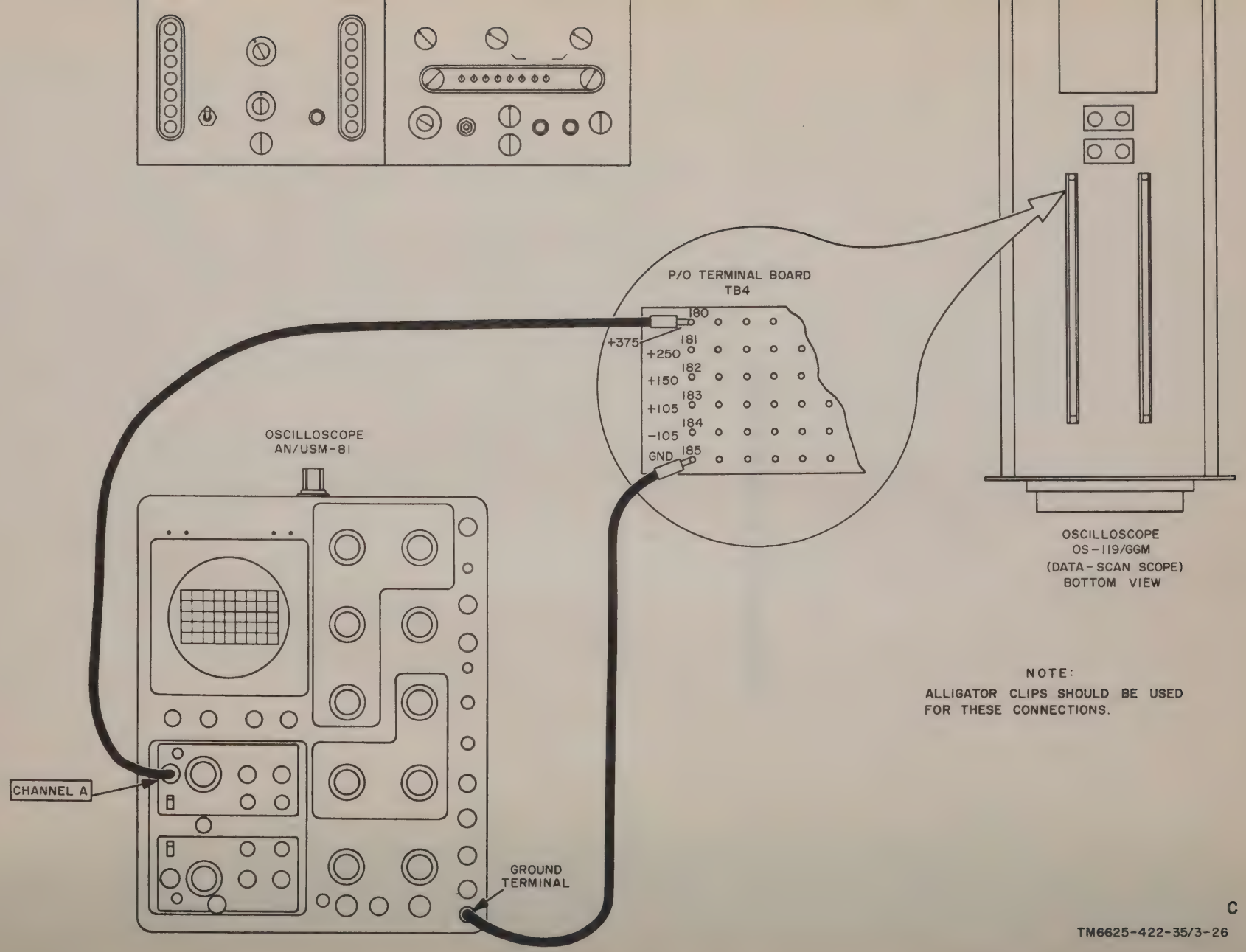
37. Ripple Voltage Test
(fig. 13)

a. *Test Equipment.*
(1) Multimeter TS-352A/U.
(2) Oscilloscope AN/USM-81.
(3) Variable Transformer CN-16B/U.
(4) Test Set, Teletypewriter AN/GGM-1 (data analysis center).

b. *Test Connections and Conditions.* Connect AN/USM-81 as shown in A, figure 13.

c. *Procedure.*

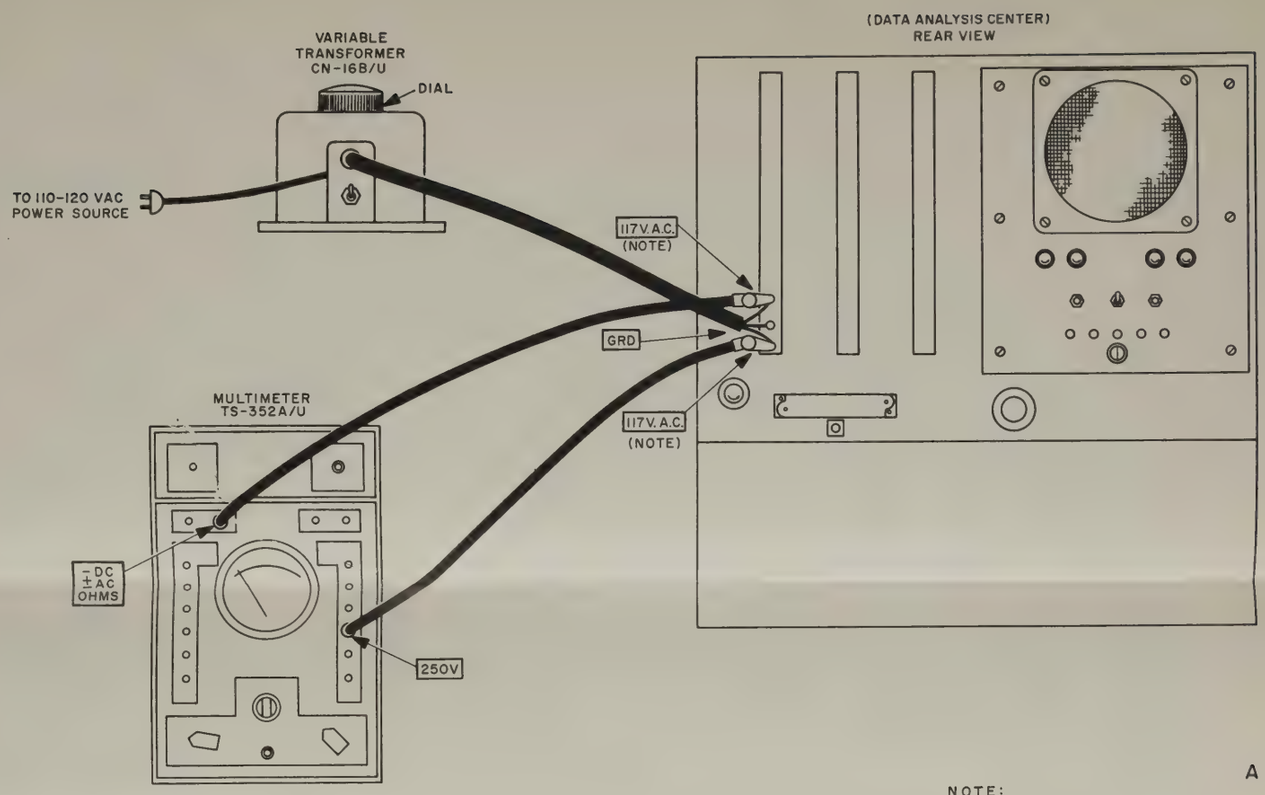
Step No.	Test equipment control settings	Equipment under test control settings	Procedure	Performance standard
1	*AN/USM-81* TRIGGERING MODE: AUTOMATIC. TRIGGER SLOPE: +INT. STABILITY: PRESET 5X MAGNIFIER: OFF TIME/CM: 1 MILLI SEC TIME/CM MULTIPLIER: 2 HORIZONTAL DISPLAY: MAIN SWEEP NORMAL. SQUARE-WAVE CALIBRATOR: 0.5 volts. VARIABLE: CALIBRATED VOLTS/CM: 0.5 MODE switch: A ONLY AC-DC switch: AC POLARITY: NORMAL POWER: ON	N/A----------	After approximately 3 minutes, vary the VERTICAL POSITION control so that the bottom of each square wave is exactly on the center horizontal line on the graticule. The top of each square wave should be 1 centimeter above the center horizontal line. Each small mark on the graticule represents 0.1 volt. Adjust SCALE ILLUM., VERTICAL POSITION, and HORIZONTAL POSITION controls as necessary.	None.
2	*TS-352A/U* FUNCTION selector: AC VOLTS *CN-16B/U* Selector dial: Maximum counterclockwise. POWER: ON	POWER: ON ----------	Connect equipment as shown in B, figure 13, and adjust CN-16B/U for an exact 117-volt indication on TS-352A/U.	TS-352A/U indicates 117 volts ac.
3	Same as at end of step 2-------	Same as at end of step 2--------	*Regulated +250-volt* a. Connect equipment as shown in C, figure 13. *Regulated +150-volt* b. Disconnect test lead from +250-volt test point on terminal board TB4 and connect it to +150-volt test point. *Regulated +1 5-volt* c. Disconnect test lead from +150-volt test point on terminal board TB4 and connect it to +150-volt test point. *Regulated -105-volt* d. Disconnect test lead from +105-volt test point on terminal board TB4 and connect it to -105-volt test point. e. Operate POWER switch on CN-16B/U and AN/USM-81 to off position.	a. Ripple voltage indicated on AN/USM-81 is below 0.3 volt. b. Ripple voltage indicated on AN/USM-81 is below 0.3 volt. c. Ripple voltage indicated on AN/USM-81 is below 0.3 volt. d. Ripple voltage indicated on AN/USM-81 is below 0.3 volt. e. None.



NOTE:
ALLIGATOR CLIPS SHOULD BE USED FOR THESE CONNECTIONS.

C

	CN-16B/U Selector dial: Maximum counter-clockwise. POWER: ON		on TS-352A/U.	
3	Same as at end of step 2 -------	Same as at end of step 2 --------	*Regulated +250-volt* *a.* Connect equipment as shown in C, figure 13. *Regulated +150-volt* *b.* Disconnect test lead from +250-volt test point on terminal board TB4 and connect it to +150-volt test point. *Regulated +1 5-volt* *c.* Disconnect test lead from +150-volt test point on terminal board TB4 and connect it to +150-volt test point. *Regulated -105-volt* *d.* Disconnect test lead from +105-volt test point on terminal board TB4 and connect it to -105-volt test point. *e.* Operate POWER switch on CN-16B/U and AN/USM-81 to off position.	*a.* Ripple voltage indicated on AN/USM-81 is below 0.3 volt. *b.* Ripple voltage indicated on AN/USM-81 is below 0.3 volt. *c.* Ripple voltage indicated on AN/USM-81 is below 0.3 volt. *d.* Ripple voltage indicated on AN/USM-81 is below 0.3 volt. *e.* None.



NOTE:

ALLIGATOR CLIPS SHOULD BE USED FOR THESE CONNECTIONS.

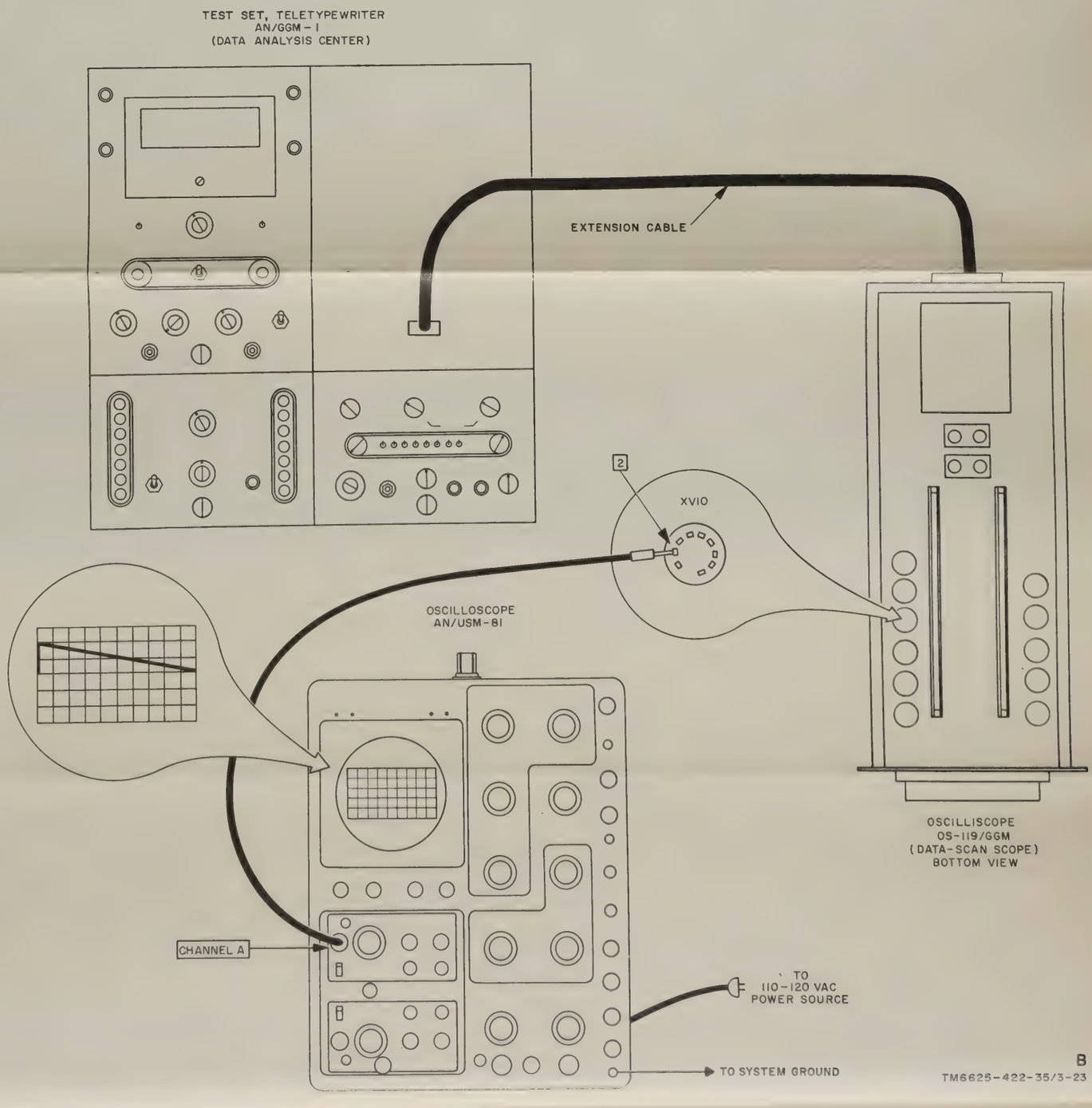


Figure 14. Test setup for free-running sweep frequency test.

38. Free-Running Sweep Frequency Test
(fig. 14)

a. Test Equipment.
(1) Multimeter TS-352A/U.
(2) Oscilloscope AN/USM-81.
(3) Variable Transformer CN-16B/U.
(4) Test Set, Teletypewriter AN/GGM-1 (data analysis center).

b. Test Connections and Conditions. Connect the equipment as shown in A, figure 14.

c. Procedures.

Step No.	Test equipment control settings	Equipment under test control settings	Procedure	Performance standard
1	*TS-352A/U* FUNCTION selector: AC VOLTS *CN-16B/U* Selector dial: Maximum counterclockwise. POWER: ON	POWER: ON ----------	Adjust CN-16B/U for an exact 117-volt indication on TS-352A/U.	TS-352A/U indicates 117 volts
2	Same as at end of step 1, except: *AN/USM-81* TRIGGERING MODE: DC TRIGGER SLOPE: +INT HORIZONTAL DISPLAY: MAIN SWEEP NORMAL. POWER: ON POLARITY: NORMAL VARIABLE: CALIBRATED VOLTS/CM: 1 VERTICAL POSITION: As necessary. MODE: A ONLY AC-DC switch: DC STABILITY: PRESET 5X MAGNIFIER: OFF TIME/CM: 10 MILLI SEC MULTIPLIER: 5	Same as at end of step 1, except: HORIZONTAL GAIN: Fully clockwise. SWEEP OPTIONS: FREE INTERNAL SWEEP MILLISECONDS COARSE: 75-300. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*a.* Connect equipment as shown in B, figure 14. *75-300 milliseconds* *b.* Adjust AN/USM-81 HORIZONTAL POSITION, VERTICAL POSITION, and TRIGGERING LEVEL controls until a stable waveform, with its left edge aligned with the left edge of the etched scale, is displayed.	*a.* None. *b.* Sweep time of waveform displayed on AN/USM-81 is 300 milliseconds, ±15.
3	Same as at end of step 2, except: *AN/USM-81* MULTIPLIER: 2	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 75 milliseconds ±3.75.
4	Same as at end of step 3 -------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: 25-80. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*25-80 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 80 milliseconds ±4.
5	Same as at end of step 2, except: TIME/CM: 1 MILLI SEC. MULTIPLIER: 5	Same as at end of step 4, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 25 milliseconds ±1.25.
6	Same as at end of step 5 -------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: 7.5-30. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*7.5-30 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 30 milliseconds ±1.5.
7	Same as at end of step 5, except: MULTIPLIER: 2.	Same as at end of step 6, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 7.5 milliseconds ±0.375.
8	Same as at end of step 7 -------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: 2.5-8. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*2.5-8 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 8 milliseconds ±0.4.
9	Same as at end of step 2, except: TIME/CM: 100 MICRO SEC MULTIPLIER: 5	Same as at end of step 8, except: INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 2.5 milliseconds (2,500 microseconds) ±0.125 (125 microseconds).
10	Same as at end of step 9 -------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: .75-3. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*0.75-3 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 3 milliseconds (3,000 microseconds) ±0.15 (150 microseconds).
11	Same as at end of step 9, except: MULTIPLIER: 2.	Same as at end of step 10, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	*a.* Same as *b*, step 2 ---------- *b.* Operate POWER switch on CN-16B/U and AN/USM-81 to OFF.	*a.* Sweep time of waveform displayed on AN/USM-81 is 0.75 milliseconds (7,500 microseconds) ±0.0375 (37.5 microseconds). *b.* None.

This page

38. Free-Running Sweep Frequency Test
(fig. 14)

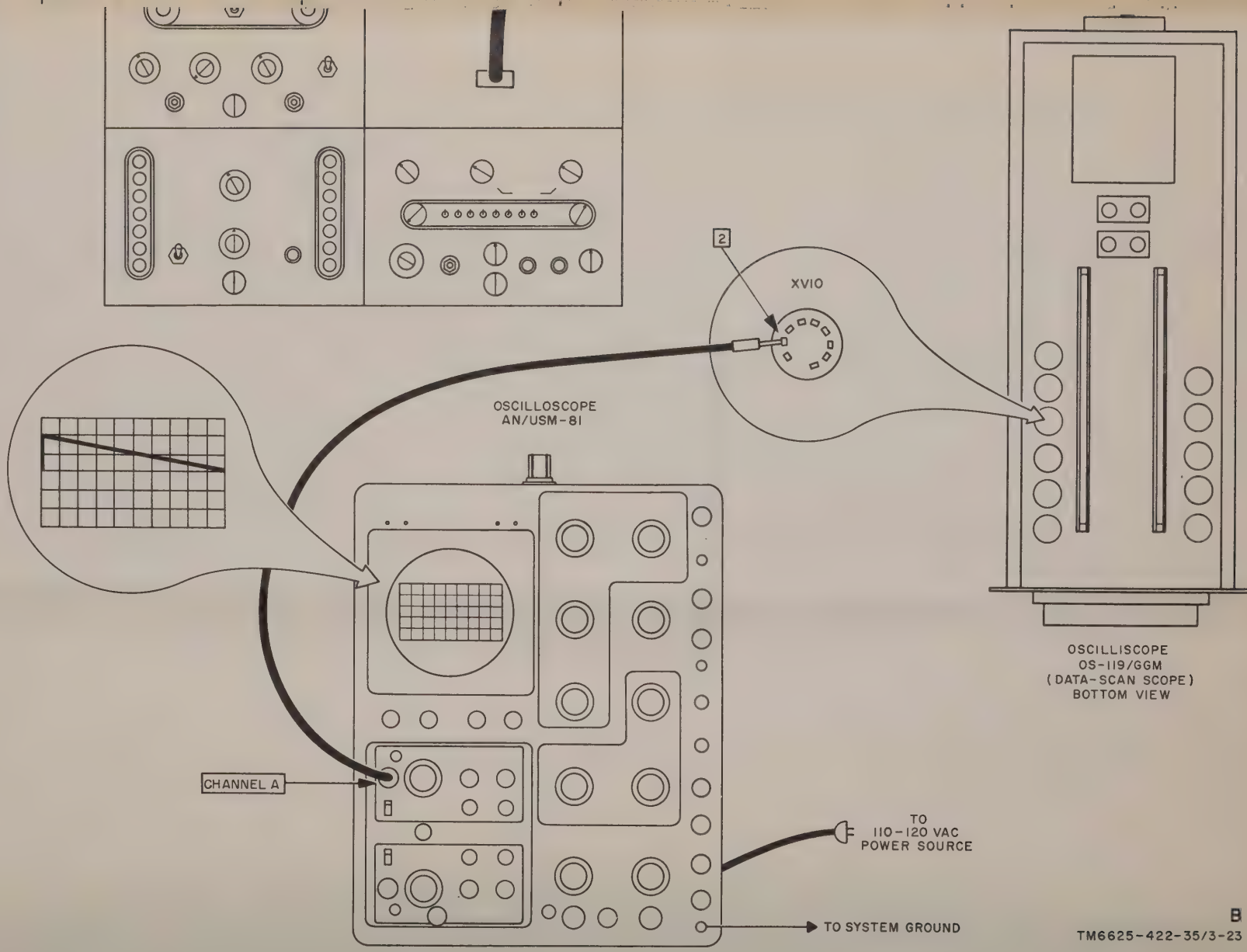
a. Test Equipment.
(1) Multimeter TS-352A/U.
(2) Oscilloscope AN/USM-81.
(3) Variable Transformer CN-16B/U.
(4) Test Set, Teletypewriter AN/GGM-1 (data analysis center).

b. Test Connections and Conditions. Connect the equipment as shown in A, figure 14.

c. Procedures.

Step No.	Test equipment control settings	Equipment under test control settings	Procedure	Performance standard
1	*TS-352A/U* FUNCTION selector: AC VOLTS *CN-16B/U* Selector dial: Maximum counterclockwise. POWER: ON	POWER: ON ----------	Adjust CN-16B/U for an exact 117-volt indication on TS-352A/U.	TS-352A/U indicates 117 volts
2	Same as at end of step 1, except: *AN/USM-81* TRIGGERING MODE: DC TRIGGER SLOPE: +INT HORIZONTAL DISPLAY: MAIN SWEEP NORMAL. POWER: ON POLARITY: NORMAL VARIABLE: CALIBRATED VOLTS/CM: 1 VERTICAL POSITION: As necessary. MODE: A ONLY AC-DC switch: DC STABILITY: PRESET 5X MAGNIFIER: OFF TIME/CM: 10 MILLI SEC MULTIPLIER: 5	Same as at end of step 1, except: HORIZONTAL GAIN: Fully clockwise. SWEEP OPTIONS: FREE INTERNAL SWEEP MILLISECONDS COARSE: 75-300. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*a.* Connect equipment as shown in B, figure 14. *75-300 milliseconds* *b.* Adjust AN/USM-81 HORIZONTAL POSITION, VERTICAL POSITION, and TRIGGERING LEVEL controls until a stable waveform, with its left edge aligned with the left edge of the etched scale, is displayed.	*a.* None. *b.* Sweep time of waveform displayed on AN/USM-81 is 300 milliseconds, ±15.
3	Same as at end of step 2, except: *AN/USM-81* MULTIPLIER: 2	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 75 milliseconds ±3.75.
4	Same as at end of step 3-------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: 25-80. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*25-80 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 80 milliseconds ±4.
5	Same as at end of step 2, except: TIME/CM: 1 MILLI SEC. MULTIPLIER: 5	Same as at end of step 4, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 25 milliseconds ±1.25.
6	Same as at end of step 5-------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: 7.5-30. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*7.5-30 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 30 milliseconds ±1.5.
7	Same as at end of step 5, except: MULTIPLIER: 2.	Same as at end of step 6, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 7.5 milliseconds ±0.375.
8	Same as at end of step 7-------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: 2.5-8. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*2.5-8 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 8 milliseconds ±0.4.
9	Same as at end of step 2, except: TIME/CM: 100 MICRO SEC MULTIPLIER: 5	Same as at end of step 8, except: INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 2.5 milliseconds (2,500 microseconds) ±0.125 (125 microseconds).
10	Same as at end of step 9-------	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: .75-3. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*0.75-3 milliseconds* Same as *b*, step 2 ----------	Sweep time of waveform displayed on AN/USM-81 is 3 milliseconds (3,000 microseconds) ±0.15 (150 microseconds).
11	Same as at end of step 9, except: MULTIPLIER: 2.	Same as at end of step 10, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	*a.* Same as *b*, step 2---------- *b.* Operate POWER switch on CN-16B/U and AN/USM-81 to OFF.	*a.* Sweep time of waveform displayed on AN/USM-81 is 0.75 milliseconds (7,500 microseconds) ±0.0375 (37.5 microseconds). *b.* None.

sweep frequency test.



B

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38. Free-Running Sweep Frequency Test
(fig. 14)

a. Test Equipment.

(1) Multimeter TS-352A/U.

8	Same as at end of step 7	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: 2.5-8. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*2.5-8 milliseconds* Same as *b*, step 2	Sweep time of waveform displayed on AN/USM-81 is 8 milliseconds ±0.4.
9	Same as at end of step 2, except: TIME/CM: 100 MICRO SEC MULTIPLIER: 5	Same as at end of step 8, except: INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	Same as *b*, step 2	Sweep time of waveform displayed on AN/USM-81 is 2.5 milliseconds (2,500 microseconds) ±0.125 (125 microseconds).
10	Same as at end of step 9	Same as at end of step 2, except: INTERNAL SWEEP MILLISECONDS COARSE: .75-3. INTERNAL SWEEP MILLISECONDS FINE: Fully counterclockwise.	*0.75-3 milliseconds* Same as *b*, step 2	Sweep time of waveform displayed on AN/USM-81 is 3 milliseconds (3,000 microseconds) ±0.15 (150 microseconds).
11	Same as at end of step 9, except: MULTIPLIER: 2.	Same as at end of step 10, except: INTERNAL SWEEP MILLISECONDS FINE: Fully clockwise.	*a.* Same as *b*, step 2 *b.* Operate POWER switch on CN-16B/U and AN/USM-81 to OFF.	*a.* Sweep time of waveform displayed on AN/USM-81 is 0.75 milliseconds (7,500 microseconds) ±0.0375 (37.5 microseconds). *b.* None.

39. Summary of Performance Standards

Arrange a checklist similar to that shown below. In the *Test indication* column, record the actual indication obtained during each of the indicated tests. This data may be used as a check against the performance standards the next time the tests are performed.

Test	Performance standard	Test indication
1. POWER SUPPLY OUTPUT VOLTAGE (para 35)		
a. Unregulated +375-volt	375 volts ±7.5	_____
b. Regulated +250-volt	250 volts ±12.5	_____
c. Regulated +150-volt	150 volts ±15	_____
d. Regulated +105-volt	105 volts ±5.25	_____
e. Regulated -105-volt	105 volts ±5.25	_____
f. Unregulated -2,300-volt	2,300 volts, ±230	_____
g. 6.3-volt ac	6.3 volts ±1	_____
2. PERCENT REGULATION (para 36)		
a. Regulated +250-volt		
(1) Low line voltage	250 volts ±7.5	_____
(2) High line voltage	250 volts ±7.5	_____
b. Regulated +150-volt		
(1) Low line voltage	150 volts ±4.5	_____
(2) High line voltage	150 volts +4.5	_____
c. Regulated +105 and -105 volt		
(1) Low line voltage	105 volts ±3.1	
(2) High line voltage	105 volts ±3.1	_____
3. RIPPLE VOLTAGE TEST (para 37)		
a. Regulated +250-volt	Below 0.3 volt	_____
b. Regulated +150-volt	Below 0.3 volt	_____
c. Regulated +105-volt	Below 0.3 volt	_____
d. Regulated -105-volt	Below 0.3 volt	_____
4. FREE-RUNNING SWEEP FREQUENCY TEST (para 38)		
a. 75-300 milliseconds	75 milliseconds ±3.75 to 300 milliseconds ±15	_____
b. 25-80 milliseconds	25 milliseconds ±1.25 to 80 milliseconds ±4.	_____
c. 7.5-30 milliseconds	7.5 milliseconds ±0.375 to 30 milliseconds ±1.5	_____
d. 2.5-8 milliseconds	2.5 milliseconds ±0.125 to 8 milliseconds ±0.4	_____
e. 0.75-3 milliseconds	0.75 milliseconds ± 0.0375 to 3 milliseconds ±0.15	_____

CHAPTER 4

FIFTH ECHELON MAINTENANCE

40. General

Fifth echelon maintenance includes rebuilding the OS-119/GGM. The fourth echelon testing procedures (para 30 through 39) can be used as final tests for a rebuilt OS-119/GGM. The tools and test equipment required for fifth echelon maintenance are the same as for fourth echelon with one exception: Test Set, Electron Tube TV-2/U, TV-2A/U, or TV-2B/U is used in place of Test Set, Electron Tube TV-7(*)/U.

41. Maintenance Procedures

Restore the appearance, performance, and life expectancy of the OS-119/GGM to a standard comparable to that of new equipment by performing the following procedures:

a. Disassemble the OS-119/GGM as required.

b. Inspect all parts and subassemblies.

c. Repair or replace any unserviceable part with a part that conforms to the original manufacturing tolerances and specifications.

d. Reassemble the OS-119/GGM.

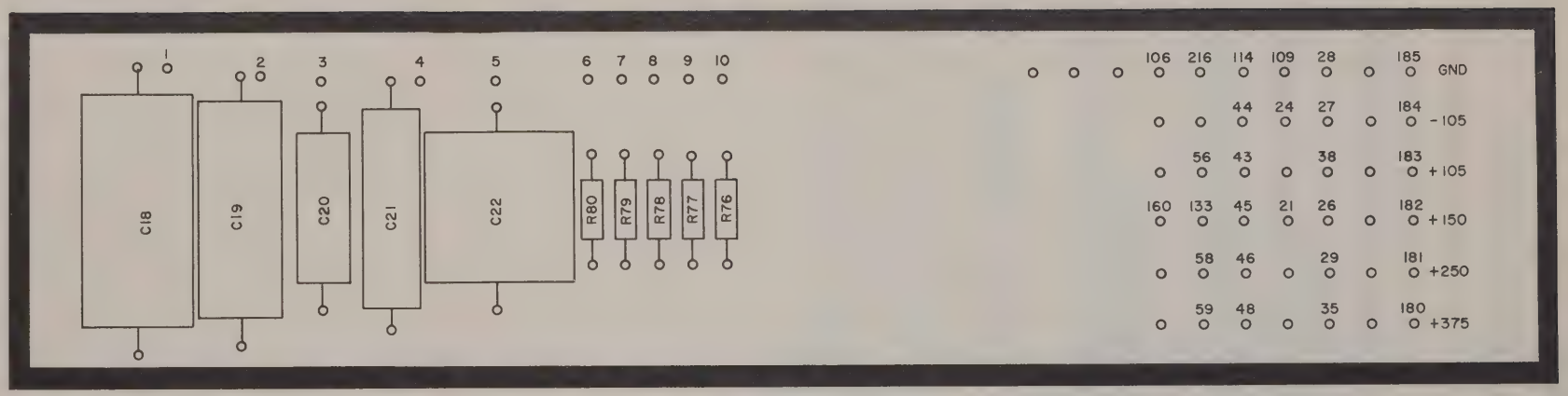
e. Perform the adjustment procedures given in paragraph 29.

f. Perform the fourth echelon testing procedures (para 30 through 39).

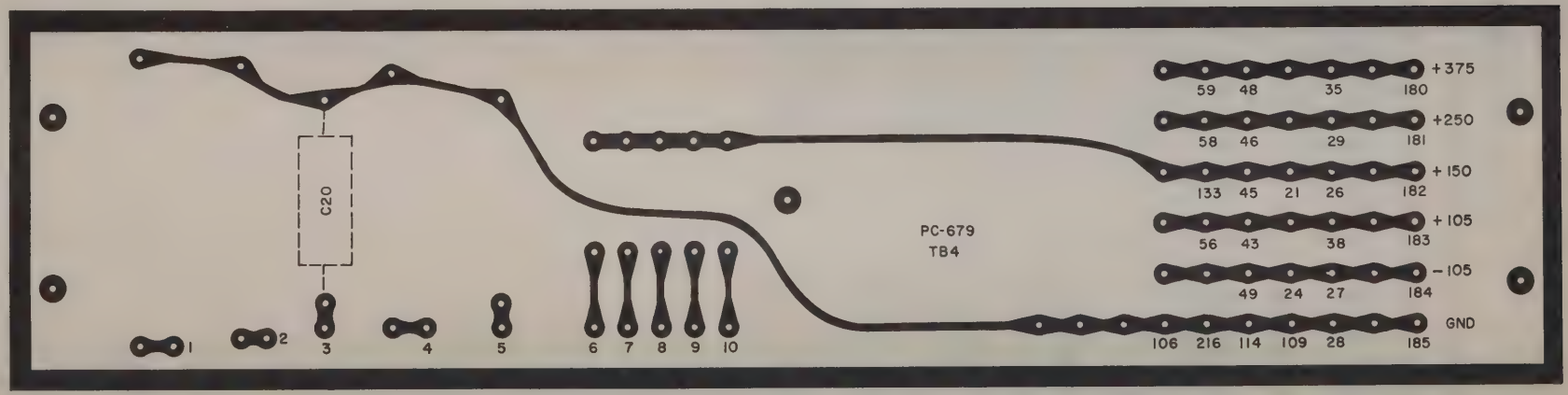
APPENDIX

REFERENCES

DA Pamphlet 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
SM 11-4-5180-S07	Tool Equipment TE-123.
TA 11-17	Signal Field Maintenance Shops.
TA 11-100 (11-17)	Allowances of Signal Corps Expendable Supplies for Signal Field Maintenance Shops.
TA 11-101 (11-1580)	Allowances for Signal Corps Expendable Supplies for Signal Depot Company.
TB Sig 222	Solder and Soldering.
TB Sig 225	Radioactive Electron Tube Handling.
TM 11-5527	Multimeters TS-352/U, TS-352A/U, and TS-352B/U.
TM 11-6625-219-12	Operator's and Organizational Maintenance Manual: Oscilloscope AN/USM-81.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-316-12	Operator and Organizational Maintenance Manual: Electron Tube Test Sets TV-2/U, TV-2A/U, and TV-2B/U.
TM 11-6625-422-12	Operator and Organizational Maintenance Manual: Test Sets, Teletypewriter AN/GGM-1, AN/GGM-2, AN/GGM-3, AN/GGM-4, and AN/GGM-5.
TOE 11-1580	Signal Depot Company.



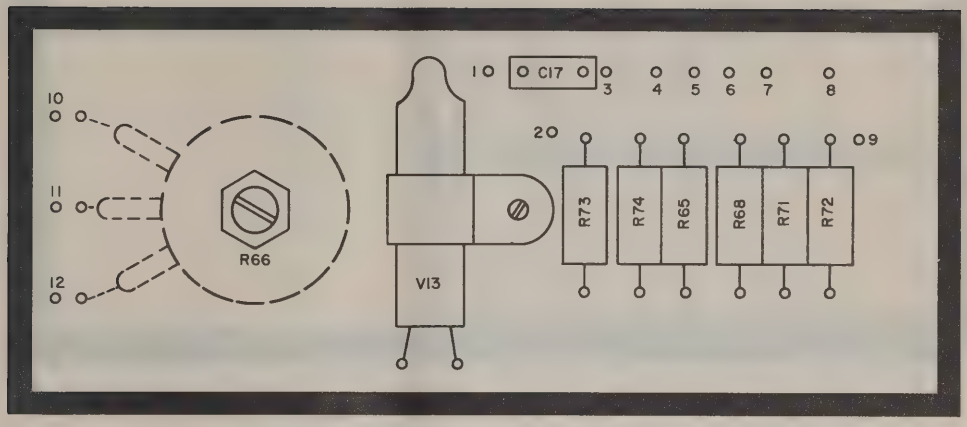
A. COMPONENTS ON COMPONENT SIDE.



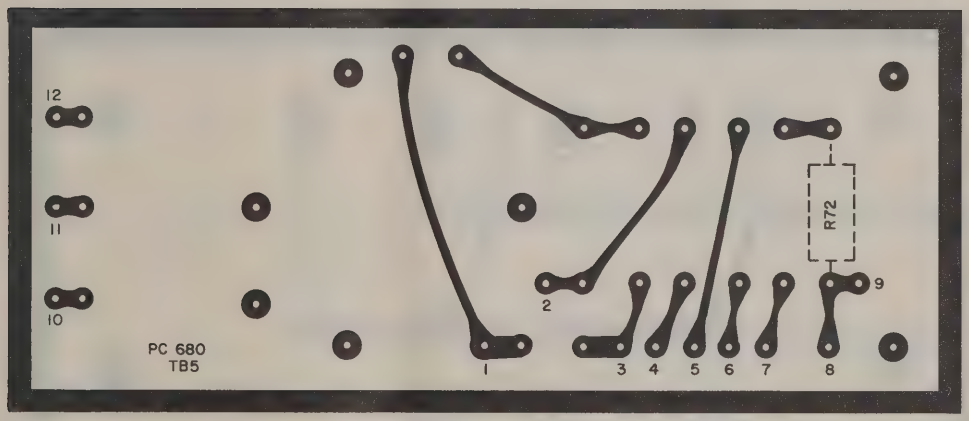
B. PRINTED WIRING SIDE.

TM6625-422-35/3-8

Figure 15. Terminal board TB4, parts location and wiring diagram.



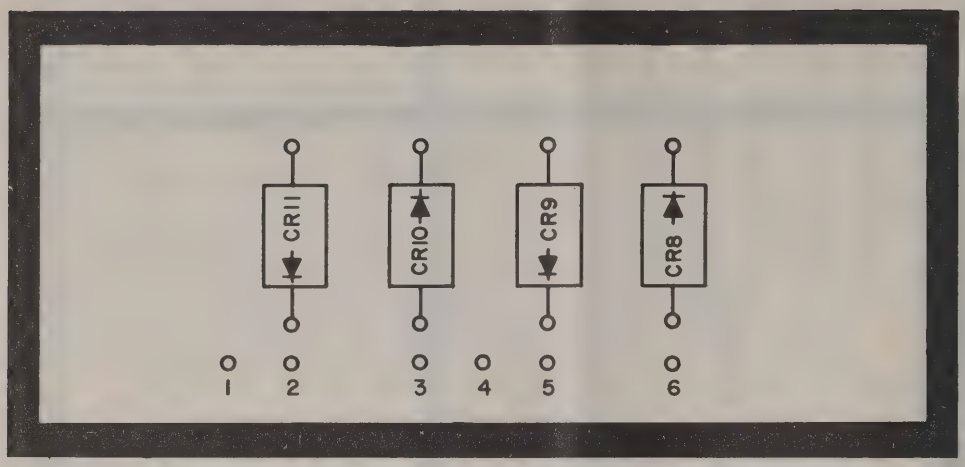
A. COMPONENTS ON COMPONENT SIDE.



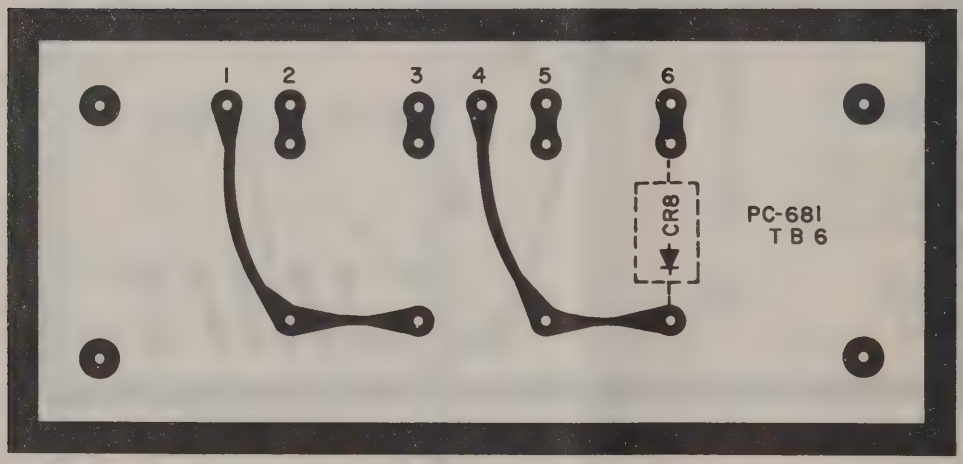
B. PRINTED WIRING SIDE.

TM6625-422-35/3-9

Figure 16. Terminal board TB5, parts location and wiring diagram.



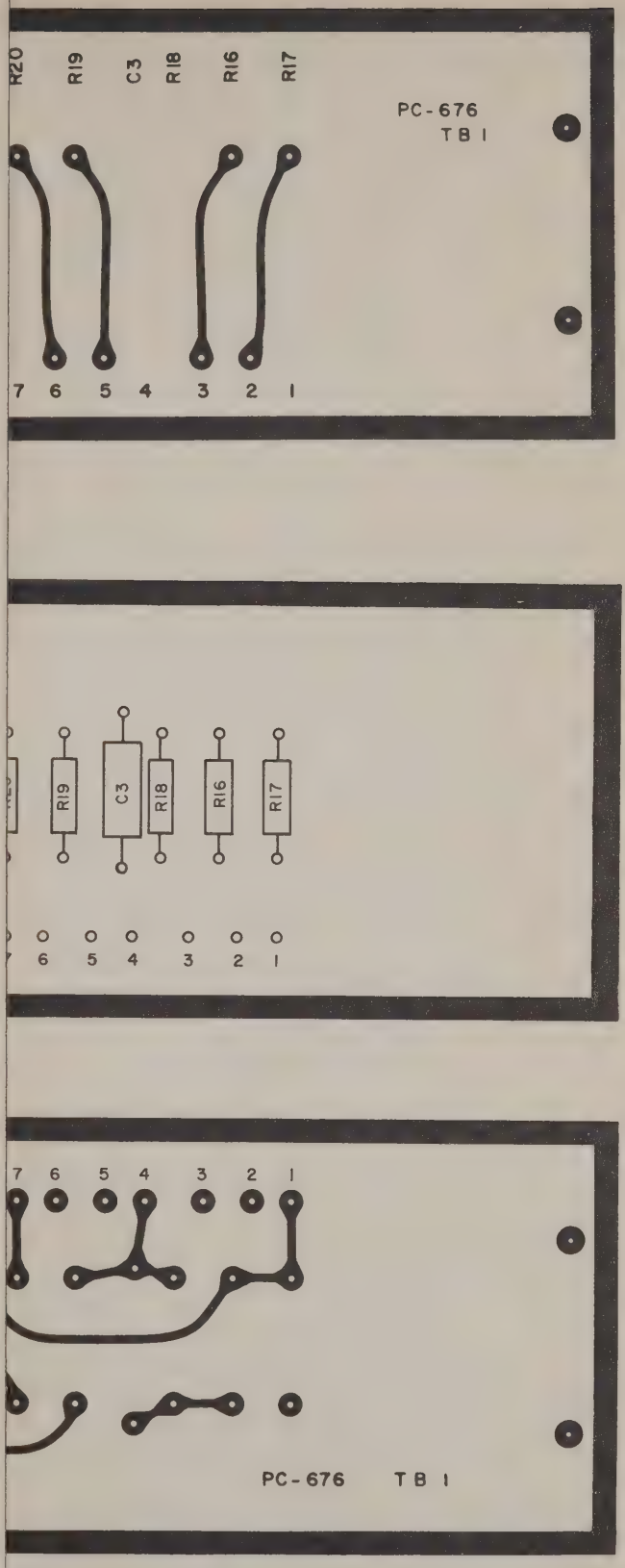
A. COMPONENTS ON COMPONENT SIDE.



B. PRINTED WIRING SIDE.

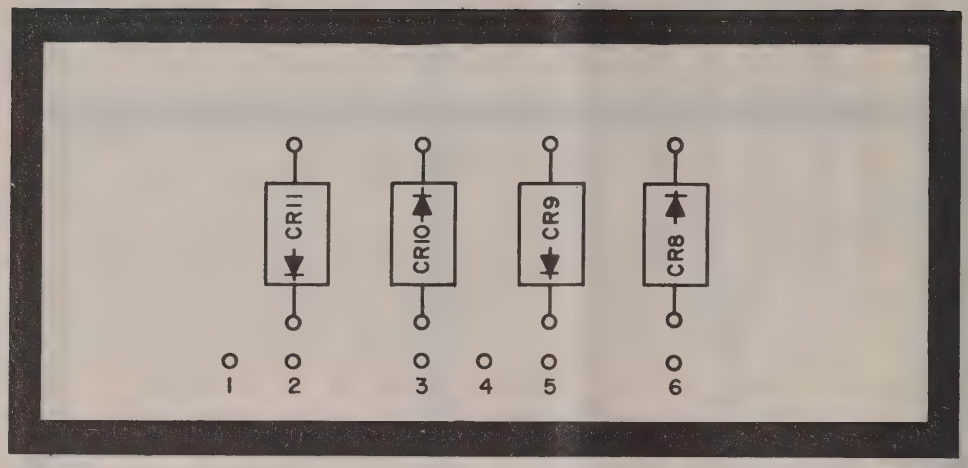
TM6625-422-35/3-10

Figure 17. Terminal board TB6, parts location and wiring diagram.

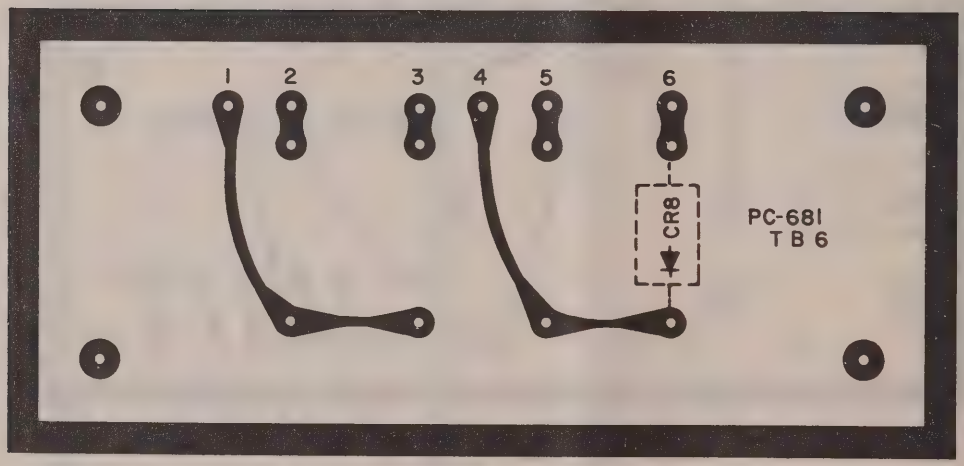


TM6625-422-35/3-5

wiring diagram.



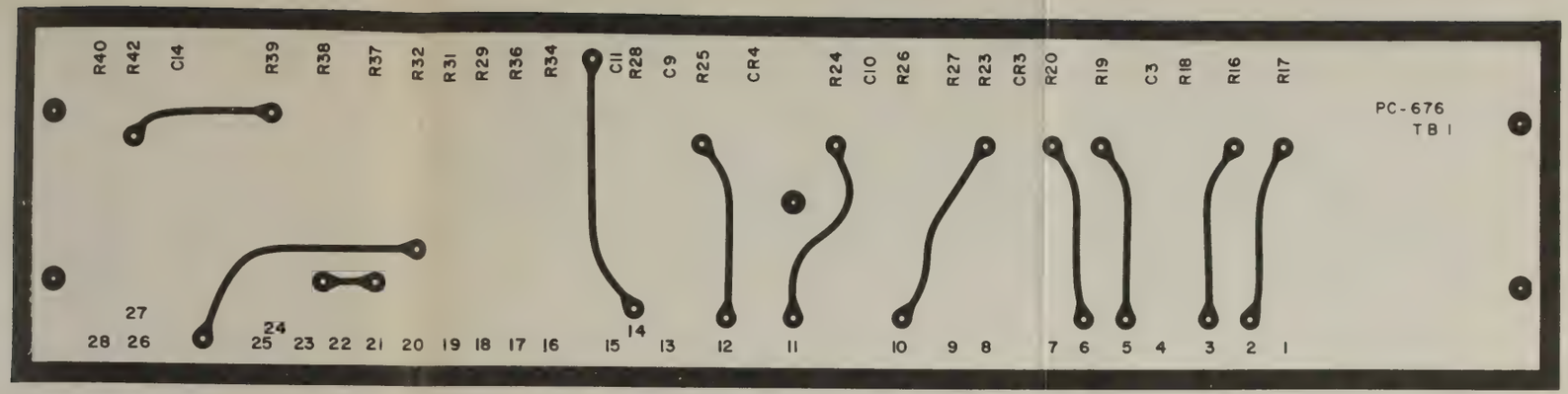
A. COMPONENTS ON COMPONENT SIDE.



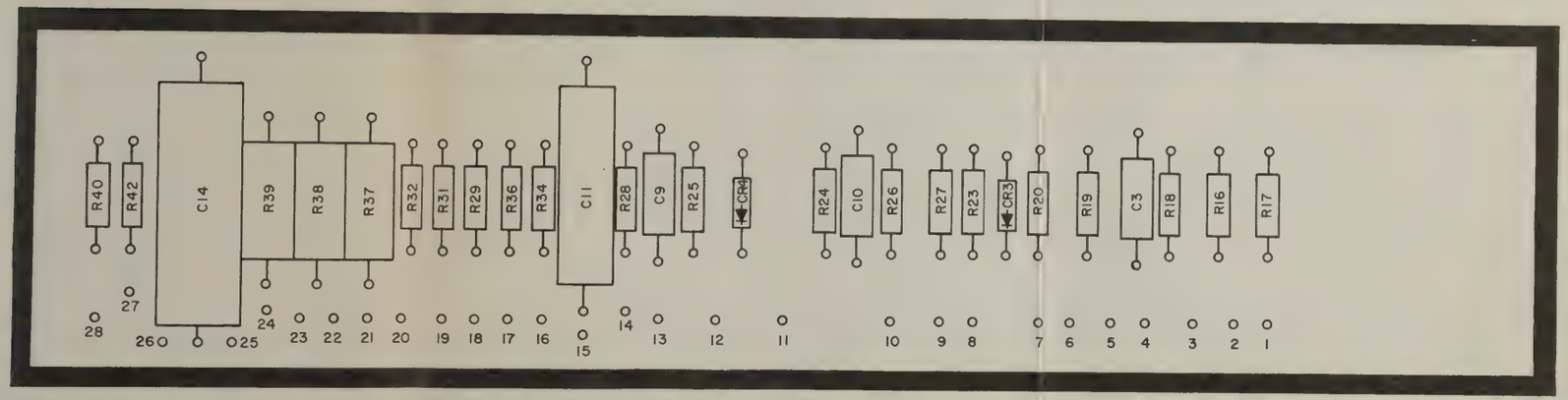
B. PRINTED WIRING SIDE.

TM6625-422-35/3-10

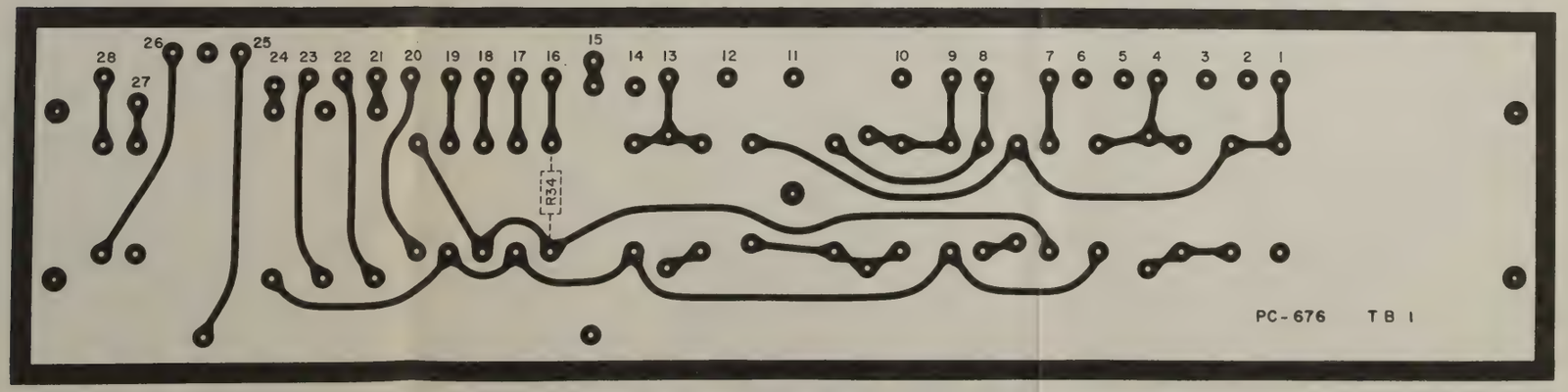
Figure 17. Terminal board TB6, parts location and wiring diagram.



A. PRINTED WIRING ON COMPONENT SIDE.



B. COMPONENTS ON COMPONENT SIDE.



C. PRINTED WIRING SIDE.

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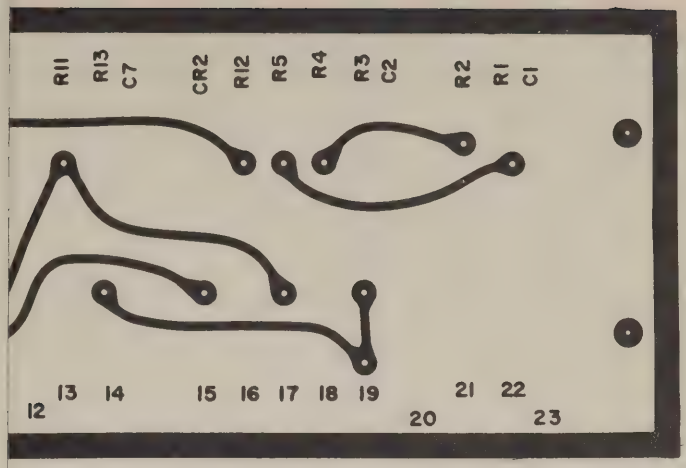
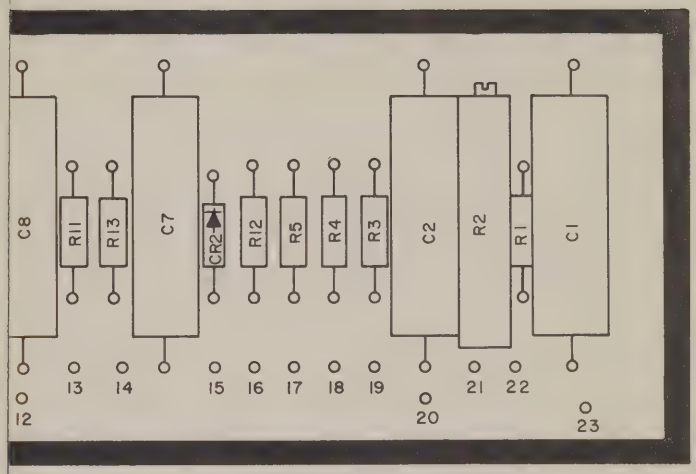
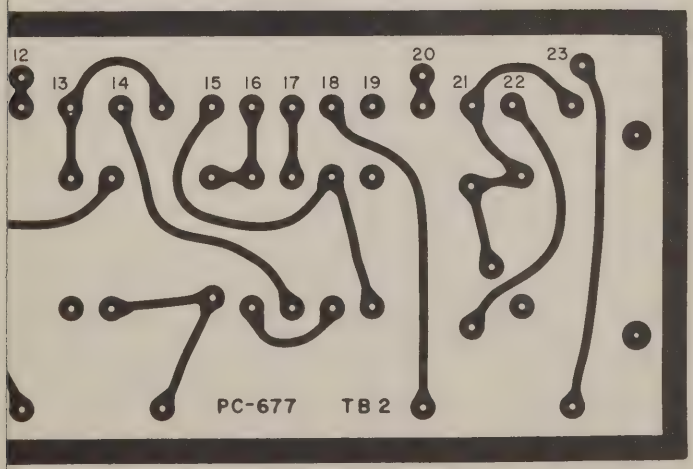
Figure 18. Terminal board TB1, parts location and wiring diagram.

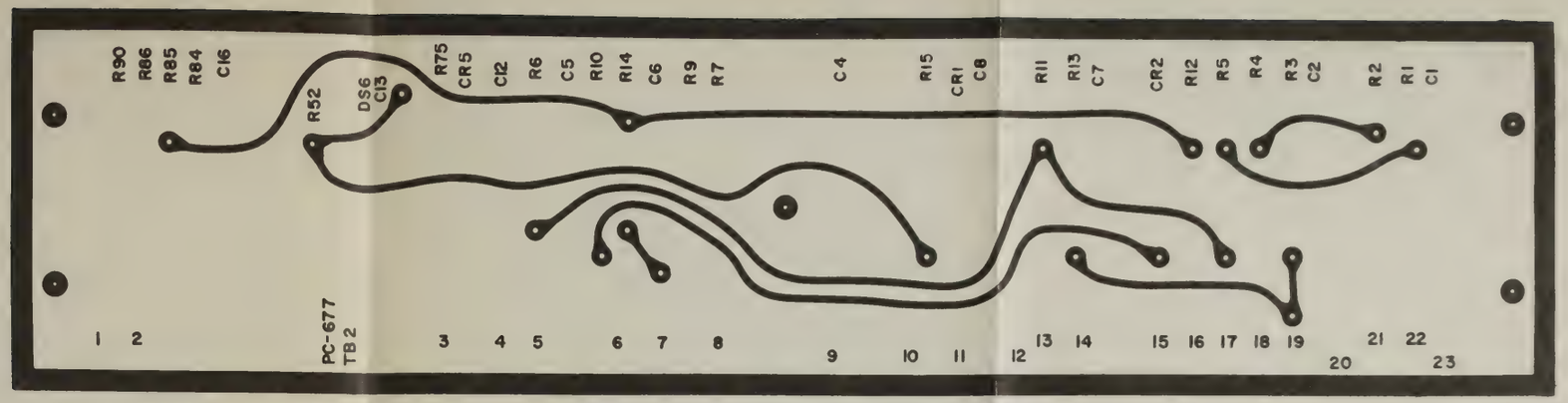




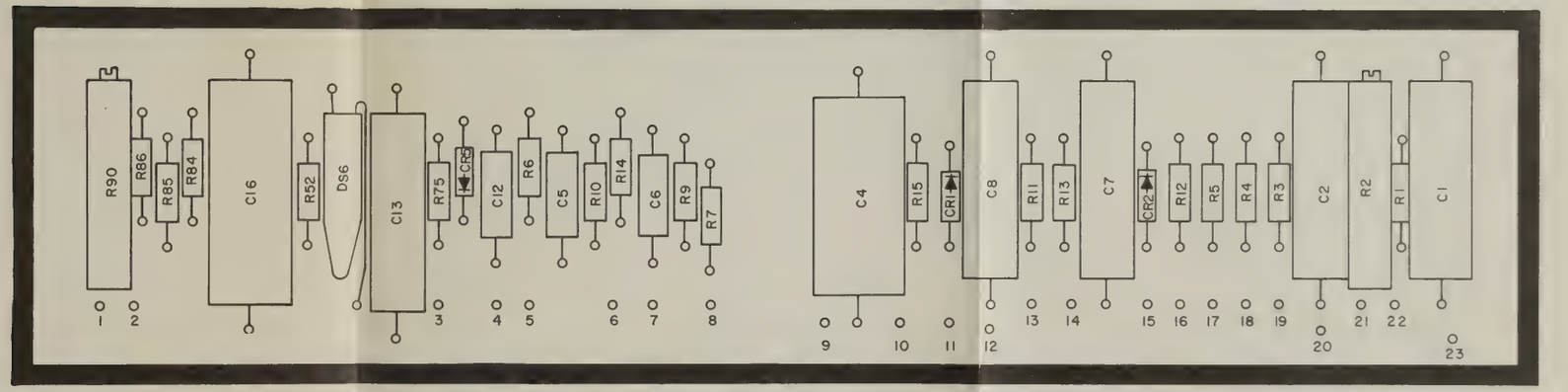


TM6625-422-35/3-6

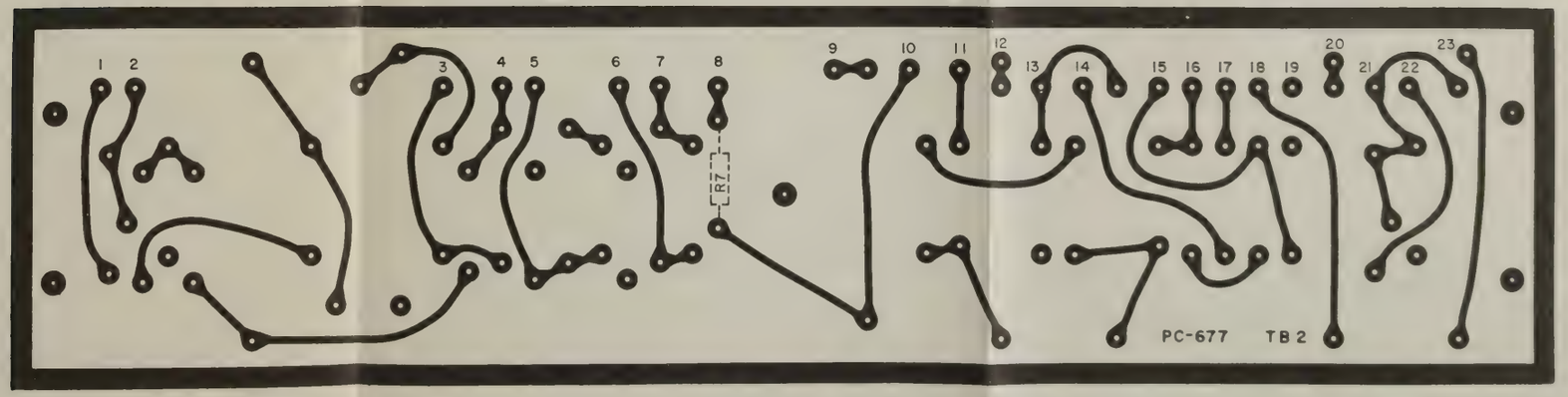
nd wiring diagram.



A. PRINTED WIRING ON COMPONENT SIDE.



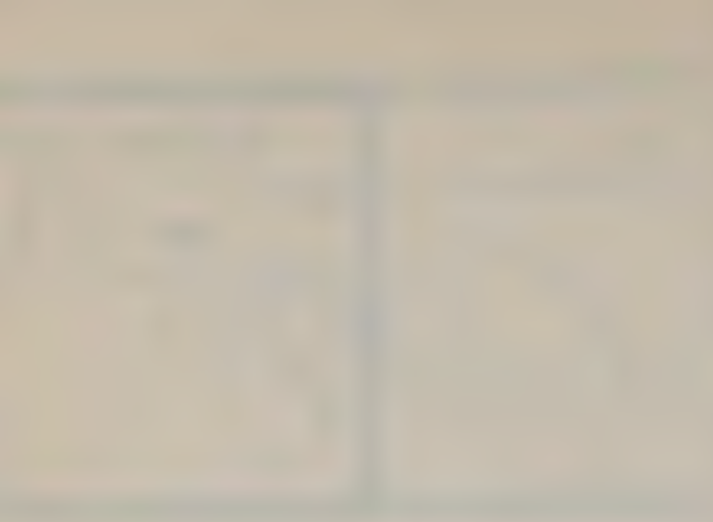
B. COMPONENTS ON COMPONENT SIDE.

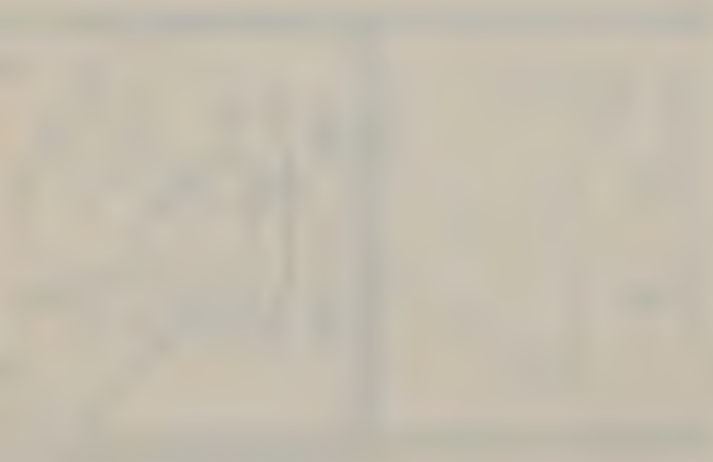


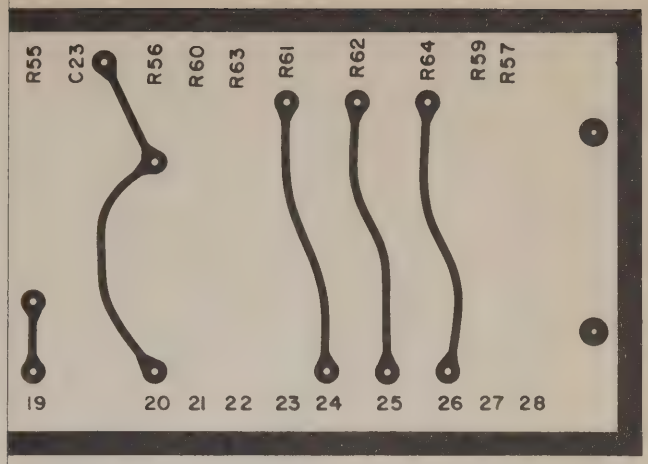
C. PRINTED WIRING SIDE.

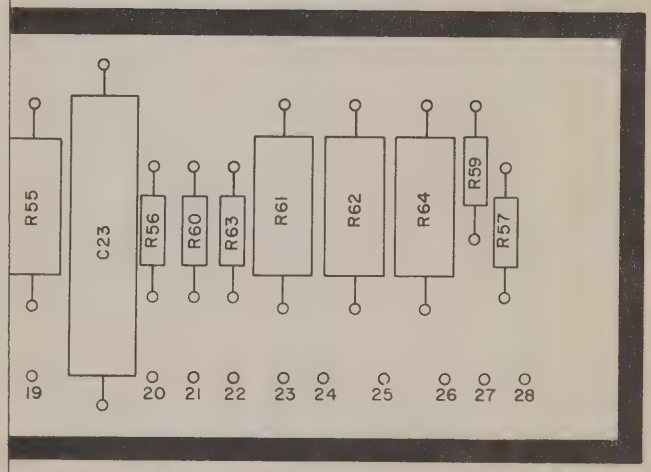
TM6625-422-35/3-6

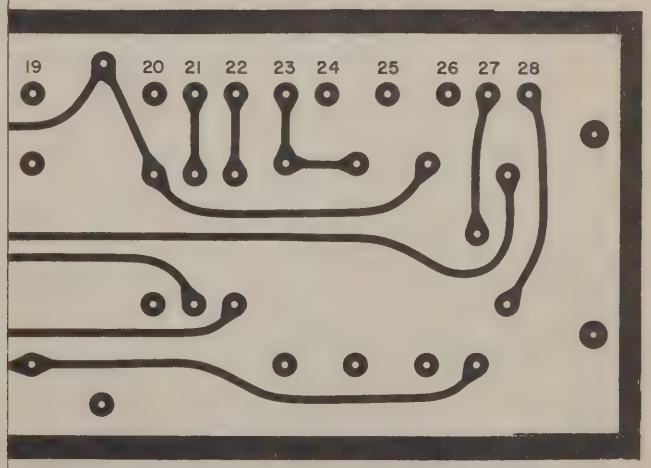
Figure 19. Terminal board TB2, parts location and wiring diagram.





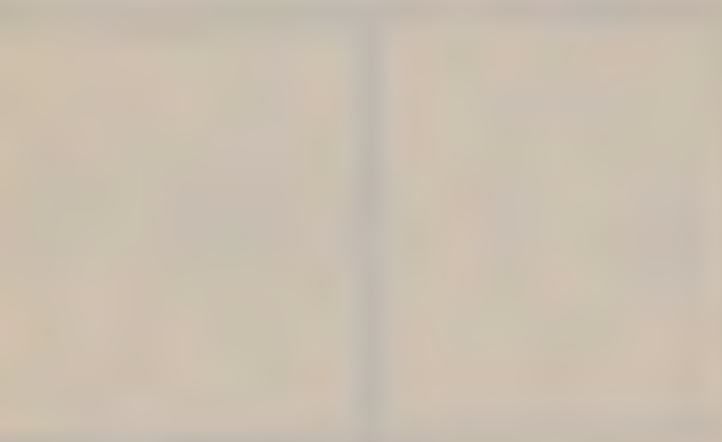


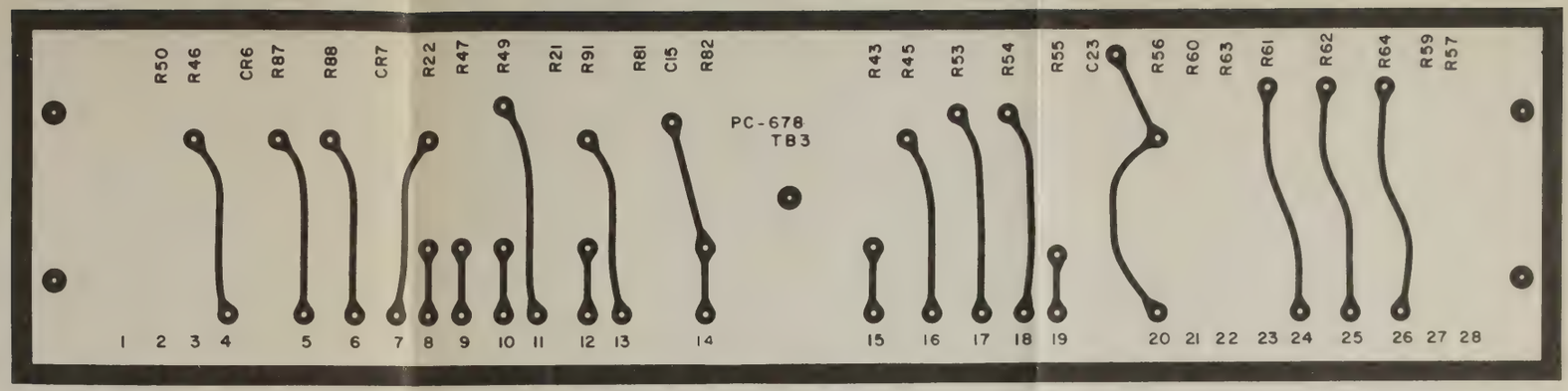




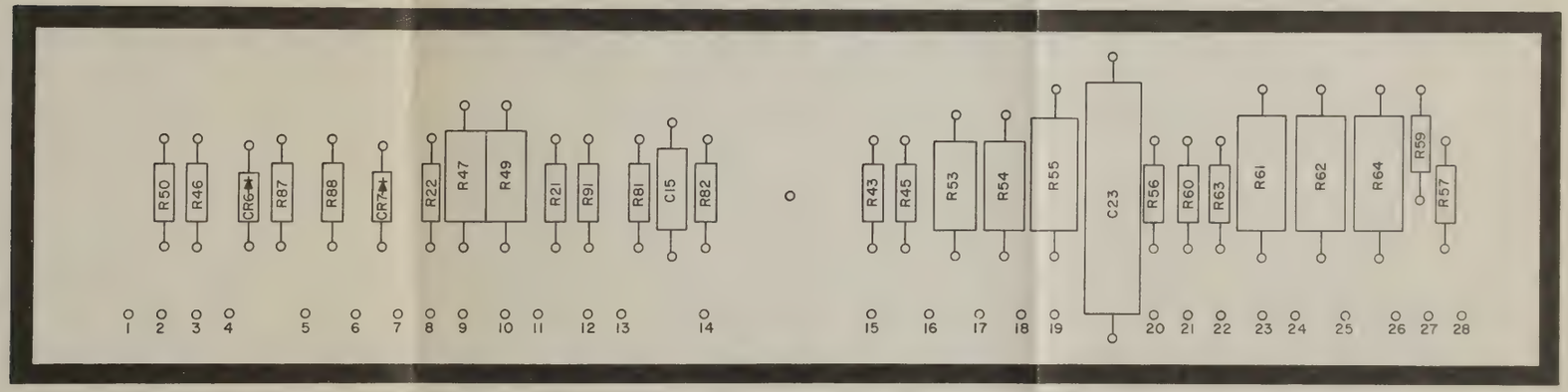
TM6625-422-35/3-7

diagram.

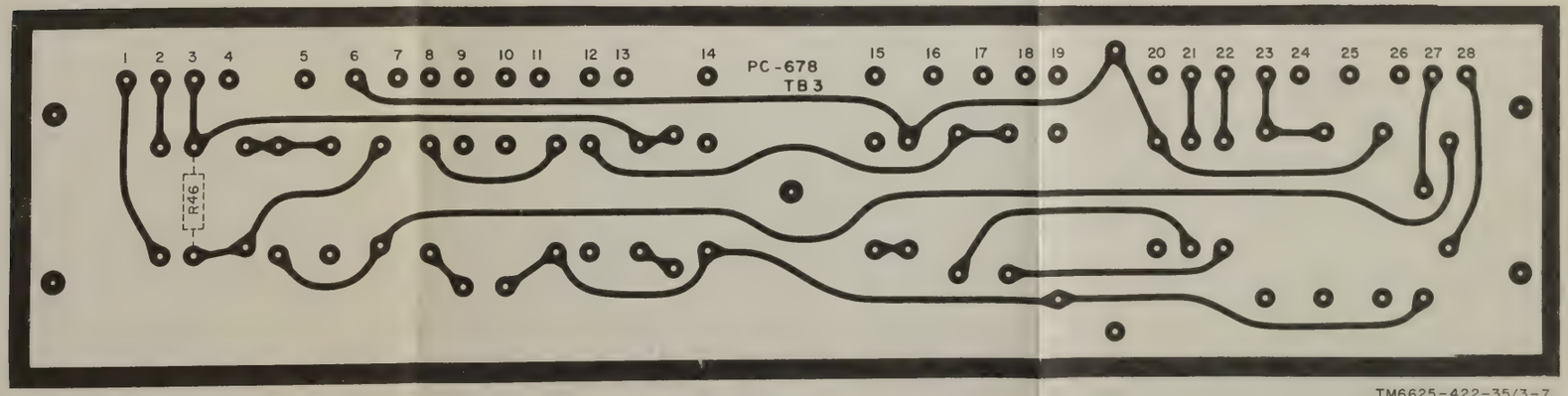




A. PRINTED WIRING ON COMPONENT SIDE.



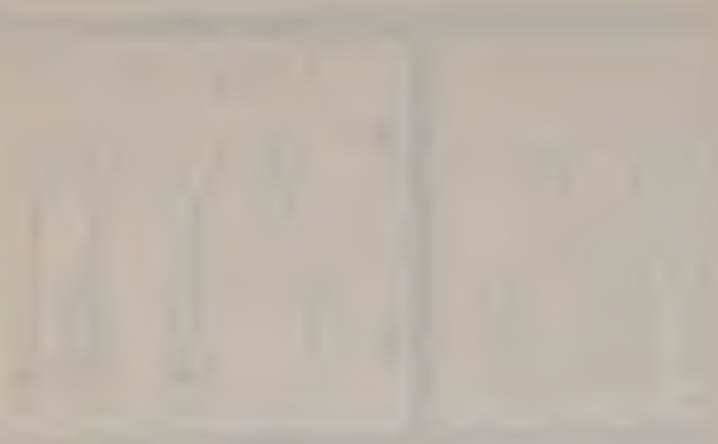
B. COMPONENTS ON COMPONENT SIDE.

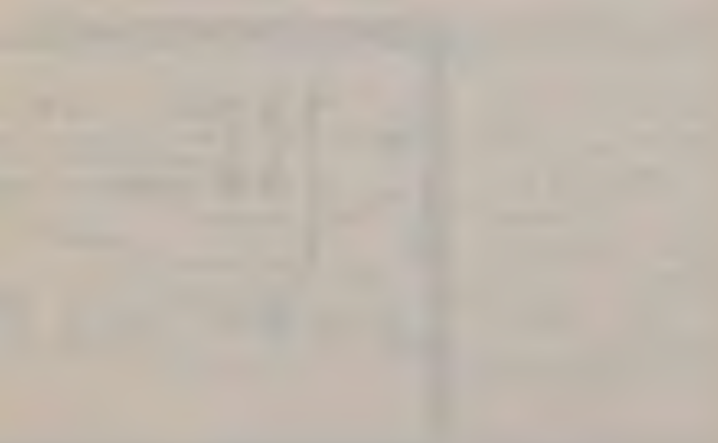


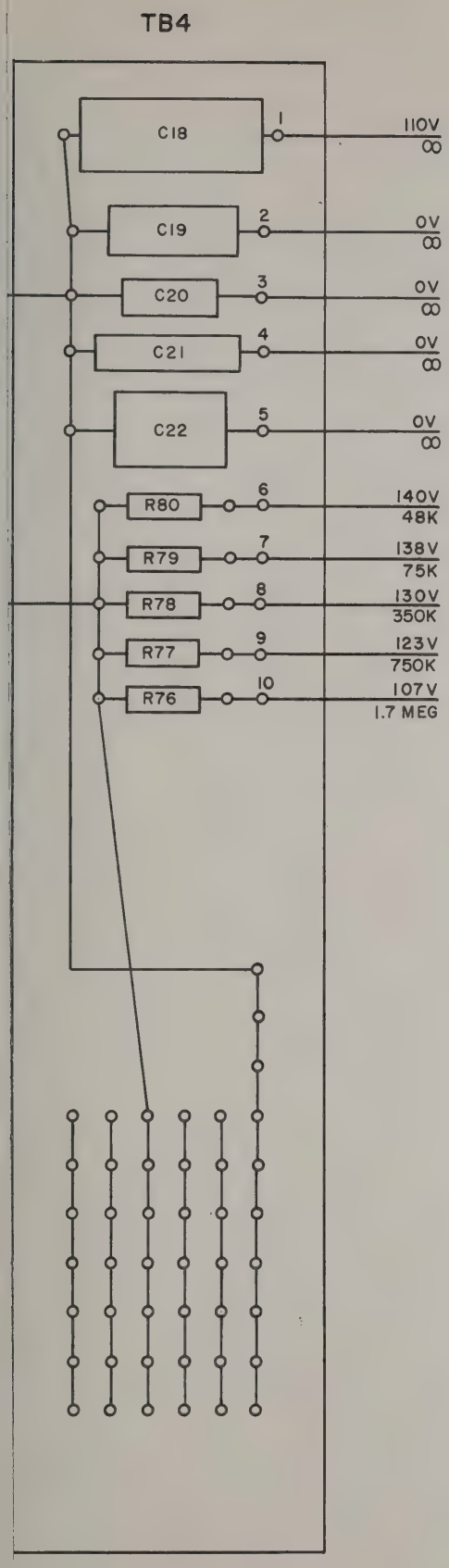
TM6625-422-35/3-7

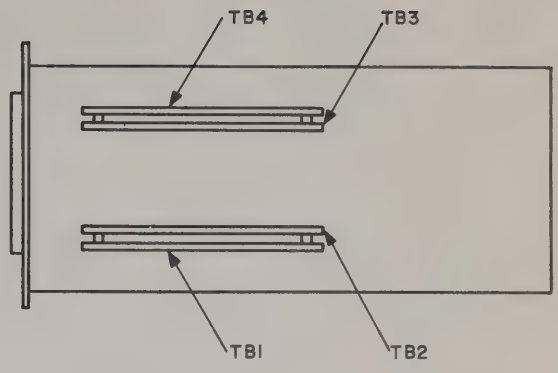
C. PRINTED WIRING SIDE.

Figure 20. Terminal board TB3, parts location and wiring diagram.









NOTES:

1. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
2. ALL VOLTAGES ARE DC, MEASURED WITH A 20,000 OHMS-PER-VOLT METER.
3. ALL VOLTAGE READINGS ARE BETWEEN POINTS INDICATED AND CHASSIS GROUND.
4. ALL RESISTANCE READINGS ARE BETWEEN POINTS INDICATED AND PIN 5 OF TRANSFORMER T2.
5. MEASUREMENTS TAKEN WITH OS-119/GGM CONTROLS IN THE FOLLOWING POSITIONS, WITH NO INPUT SIGNALS:

FRONT PANEL CONTROL	POSITION
SWEEP OPTIONS	TRIGGERED
INTENSITY MARKERS	OFF
CHARACTER BLANKING SELECT	OFF
INTERNAL SWEEP MILLISECONDS COARSE.	75 - 300
ALL OTHER CONTROLS	FULLY CCW

6. CONNECTIONS SHOWN ON TERMINAL BOARD REPRESENT PRINTED WIRING.
7. UNLESS OTHERWISE SPECIFIED, RESISTANCES ARE IN OHMS, AND ARE MEASURED WITH EXTENSION CABLE DISCONNECTED.

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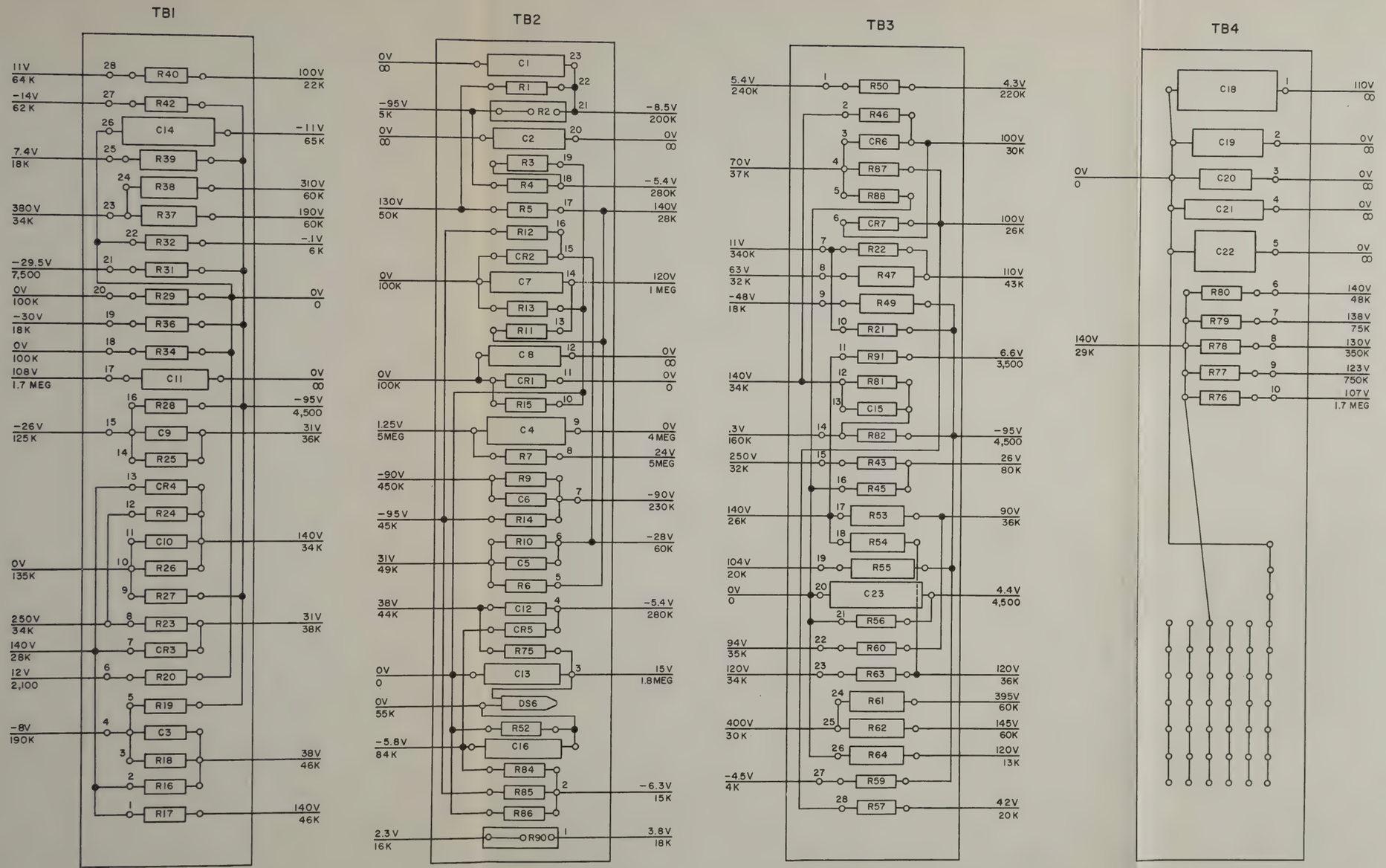


Figure 21. Terminal boards (underside of chassis), voltage and resistance diagram.

NOTES:

1. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
2. ALL VOLTAGES ARE DC, MEASURED WITH A 20,000 OHMS-PER-VOLT METER.
3. ALL VOLTAGE READINGS ARE BETWEEN POINTS INDICATED AND CHASSIS GROUND.
4. ALL RESISTANCE READINGS ARE BETWEEN POINTS INDICATED AND PIN 5 OF TRANSFORMER T2.
5. MEASUREMENTS TAKEN WITH OS-119/GGM CONTROLS IN THE FOLLOWING POSITIONS, WITH NO INPUT SIGNALS:

FRONT PANEL CONTROL	POSITION
SWEEP OPTIONS	TRIGGERED
INTENSITY MARKERS	OFF
CHARACTER BLANKING SELECT	OFF
INTERNAL SWEEP MILLISECONDS COARSE.	75 - 300
ALL OTHER CONTROLS	FULLY CCW

6. CONNECTIONS SHOWN ON TERMINAL BOARD REPRESENT PRINTED WIRING.
7. UNLESS OTHERWISE SPECIFIED, RESISTANCES ARE IN OHMS, AND ARE MEASURED WITH EXTENSION CABLE DISCONNECTED.

TM6625-422-35/3-21

COLOR CODE TABLES

and CB

APACITANCE TOLERANCE			CHARACTERISTIC[2]				DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
CN	CY	CB	CM	CN	CY	CB	CM	CM	CM
	± 20%	± 20%		A				−55° to +70°C	10–55 cps
			B	E		B			
	± 2%	± 2%	C		C			−55° to +85°C	
± 30%			D			D	300		
			E					−55° to +125°C	10–2,000 cps
			F				500		
								−55° to +150°C	
	± 5%	± 5%							
± 10%	± 10%	± 10%							

Style CK

CAPACITANCE TOLERANCE	MIL ID
± 20%	
± 10%	
	CK

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		± 5%	± 0.5uuf	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

nt (SIG) figures are multiplied to obtain the capacitance in uuf.

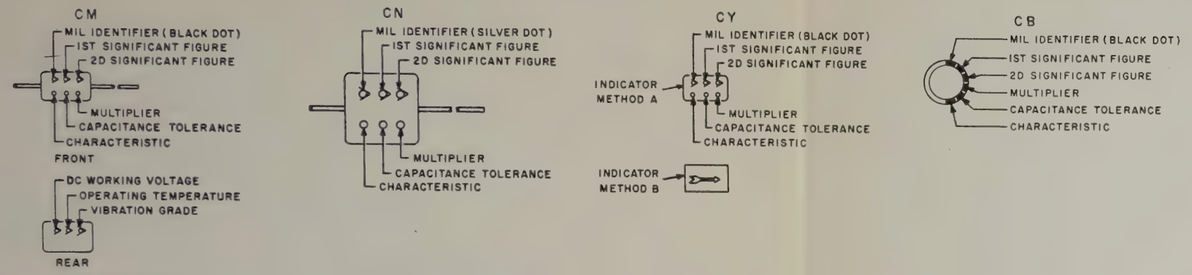
able specifications: MIL–C–5, MIL–C–91, MIL–C–11272, and MIL–C–10950 respectively.

perature limits designated in MIL–C–11015.

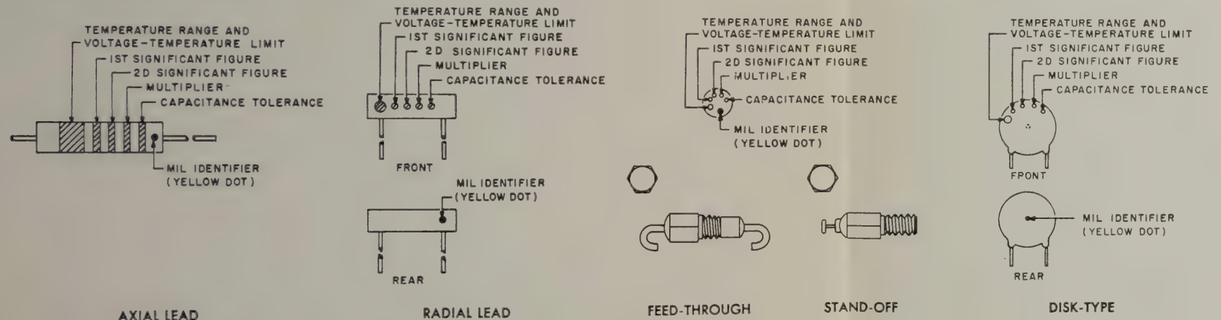
centigrade.

COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS

GROUP I Capacitors, Fixed, Various-Dielectrics, Styles CM, CN, CY, and CB



GROUP II Capacitors, Fixed Ceramic-Dielectric (General Purpose) Style CK



GROUP III Capacitors, Fixed, Ceramic-Dieletric (Temperature Compensating) Style CC

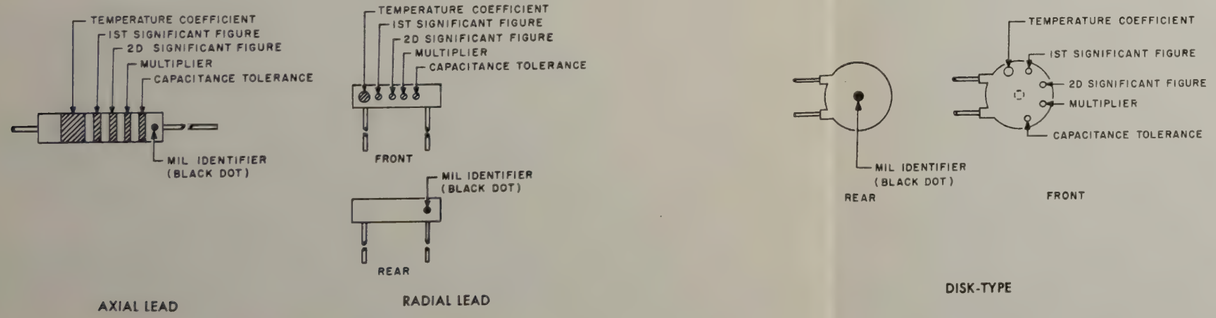


Figure 22. MIL-STD capacitor color code markings.

COLOR CODE TABLES

TABLE I – For use with Group I, Styles CM, CN, CY and CB

COLOR	MIL ID	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]				DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CY	CB	CM	CM	CM
BLACK	CM, CY CB	0	0	1			± 20%	± 20%		A				−55° to +70°C	10–55 cps
BROWN		1	1	10					B	E		B			
RED		2	2	100	± 2%		± 2%	± 2%	C		C			−55° to +85°C	
ORANGE		3	3	1,000		± 30%			D			D	300		
YELLOW		4	4	10,000					E					−55° to +125°C	10–2,000 cps
GREEN		5	5		± 5%				F				500		
BLUE		6	6											−55° to +150°C	
PURPLE (VIOLET)		7	7												
GREY		8	8												
WHITE		9	9												
GOLD				0.1			± 5%	± 5%							
SILVER	CN				± 10%	± 10%	± 10%	± 10%							

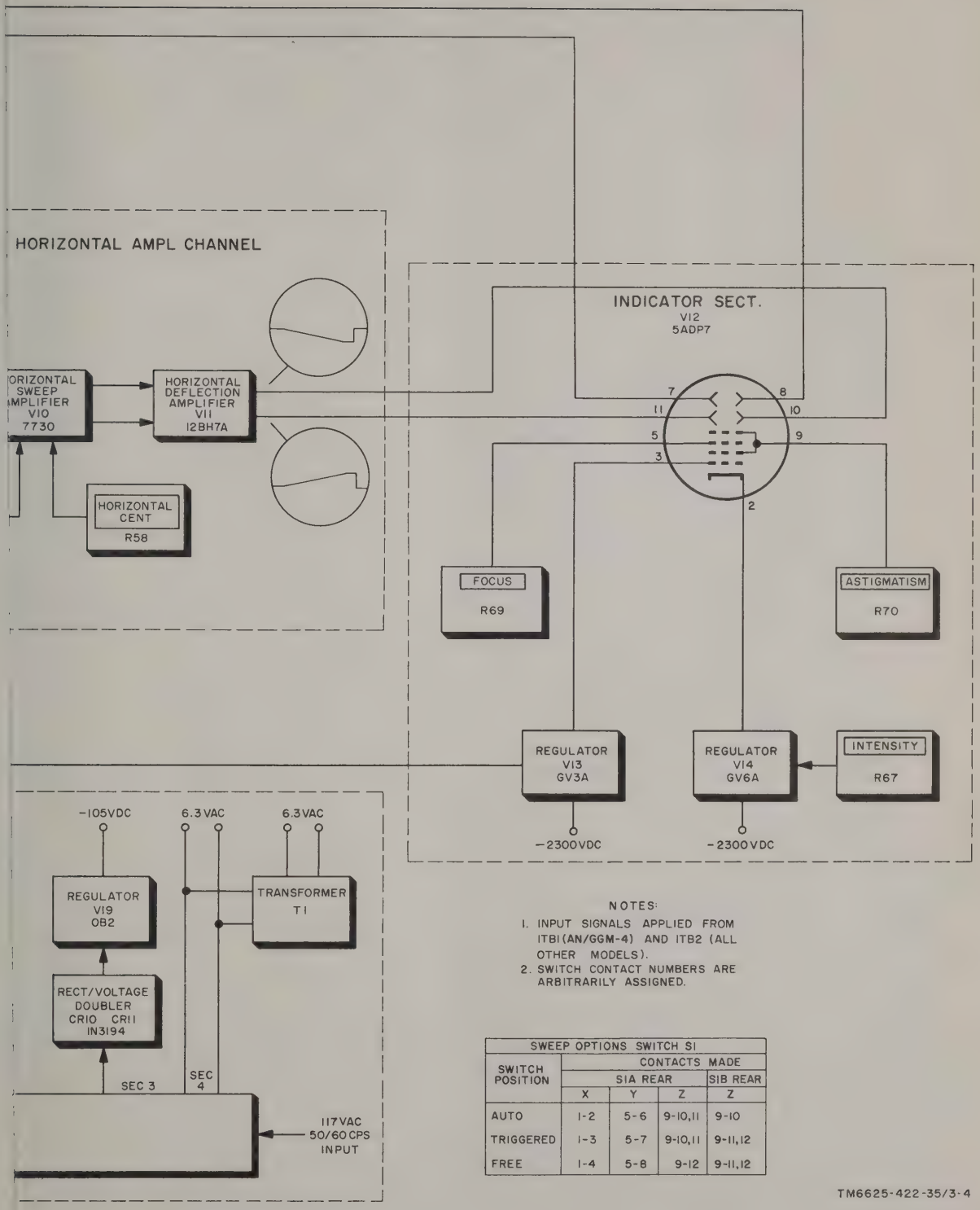
TABLE II – For use with Group II, General Purpose, Style CK

COLOR	TEMP. RANGE AND VOLTAGE – TEMP. LIMITS[3]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE	MIL ID
BLACK		0	0	1	± 20%	
BROWN	AW	1	1	10	± 10%	
RED	AX	2	2	100		
ORANGE	BX	3	3	1,000		
YELLOW	AV	4	4	10,000		CK
GREEN	CZ	5	5			
BLUE	BV	6	6			
PURPLE (VIOLET)		7	7			
GREY		8	8			
WHITE		9	9			
GOLD						
SILVER						

TABLE III – For use with Group III, Temperature Compensating, Style CC

COLOR	TEMPERATURE COEFFICIENT[4]	1st SIG FIG	2nd SIG FIG	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					Capacitances over 10uuf	Capacitances 10uuf or less	
BLACK	0	0	0	1		± 2.0uuf	CC
BROWN	−30	1	1	10	± 1%		
RED	−80	2	2	100	± 2%	± 0.25uuf	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		± 5%	± 0.5uuf	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	± 10%		
GOLD	+100					± 1.0uuf	
SILVER							

1. The multiplier is the number by which the two significant (SIG) figures are multiplied to obtain the capacitance in uuf.
2. Letters indicate the Characteristics designated in applicable specifications: MIL–C–5, MIL–C–91, MIL–C–11272, and MIL–C–10950 respectively.
3. Letters indicate the temperature range and voltage-temperature limits designated in MIL–C–11015.
4. Temperature coefficient in parts per million per degree centigrade.



NOTES:

1. INPUT SIGNALS APPLIED FROM 1TB1(AN/GGM-4) AND 1TB2 (ALL OTHER MODELS).
2. SWITCH CONTACT NUMBERS ARE ARBITRARILY ASSIGNED.

SWEEP OPTIONS SWITCH S1				
SWITCH POSITION	CONTACTS MADE			
	S1A REAR			S1B REAR
	X	Y	Z	Z
AUTO	1-2	5-6	9-10,11	9-10
TRIGGERED	1-3	5-7	9-10,11	9-11,12
FREE	1-4	5-8	9-12	9-11,12

TM6625-422-35/3-4

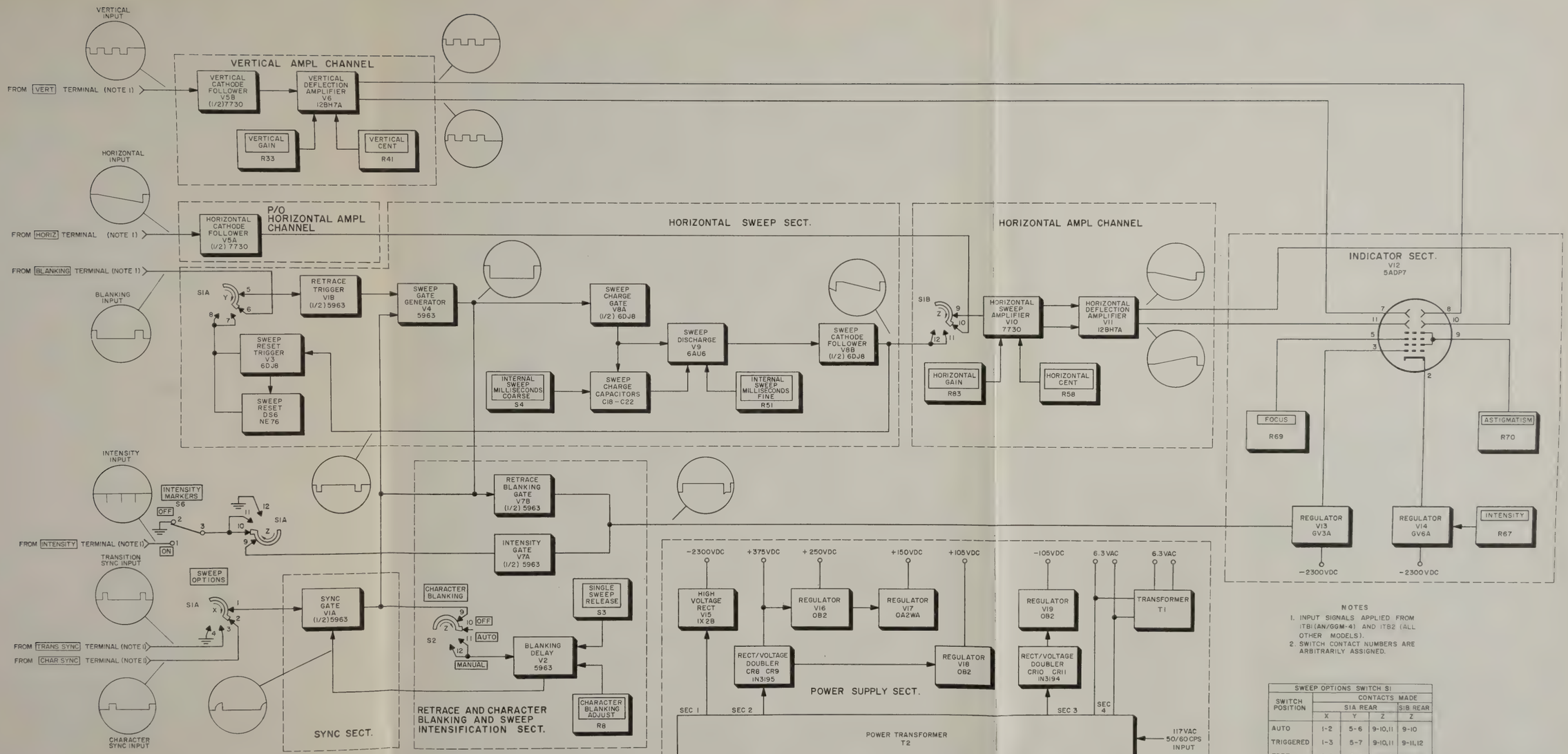


Figure 23. Oscilloscope OS-119/GGM, block diagram.

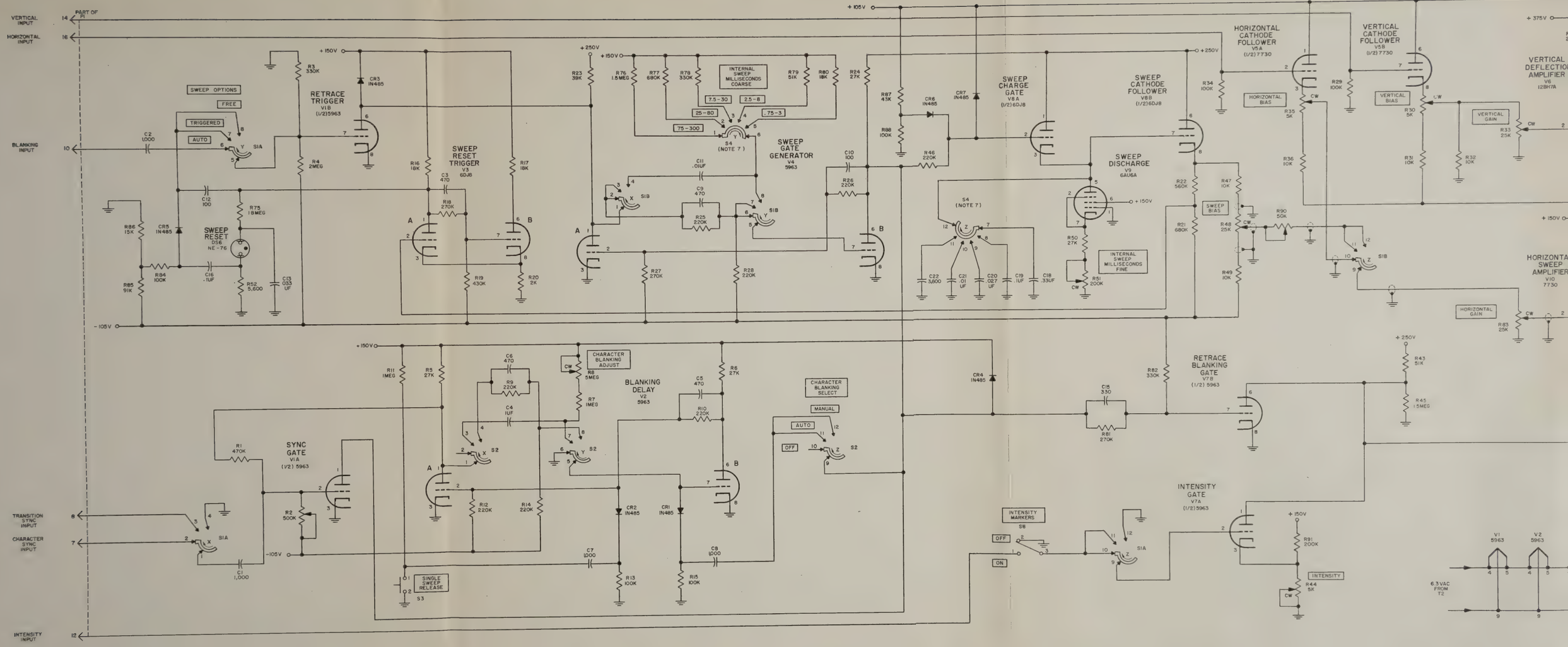
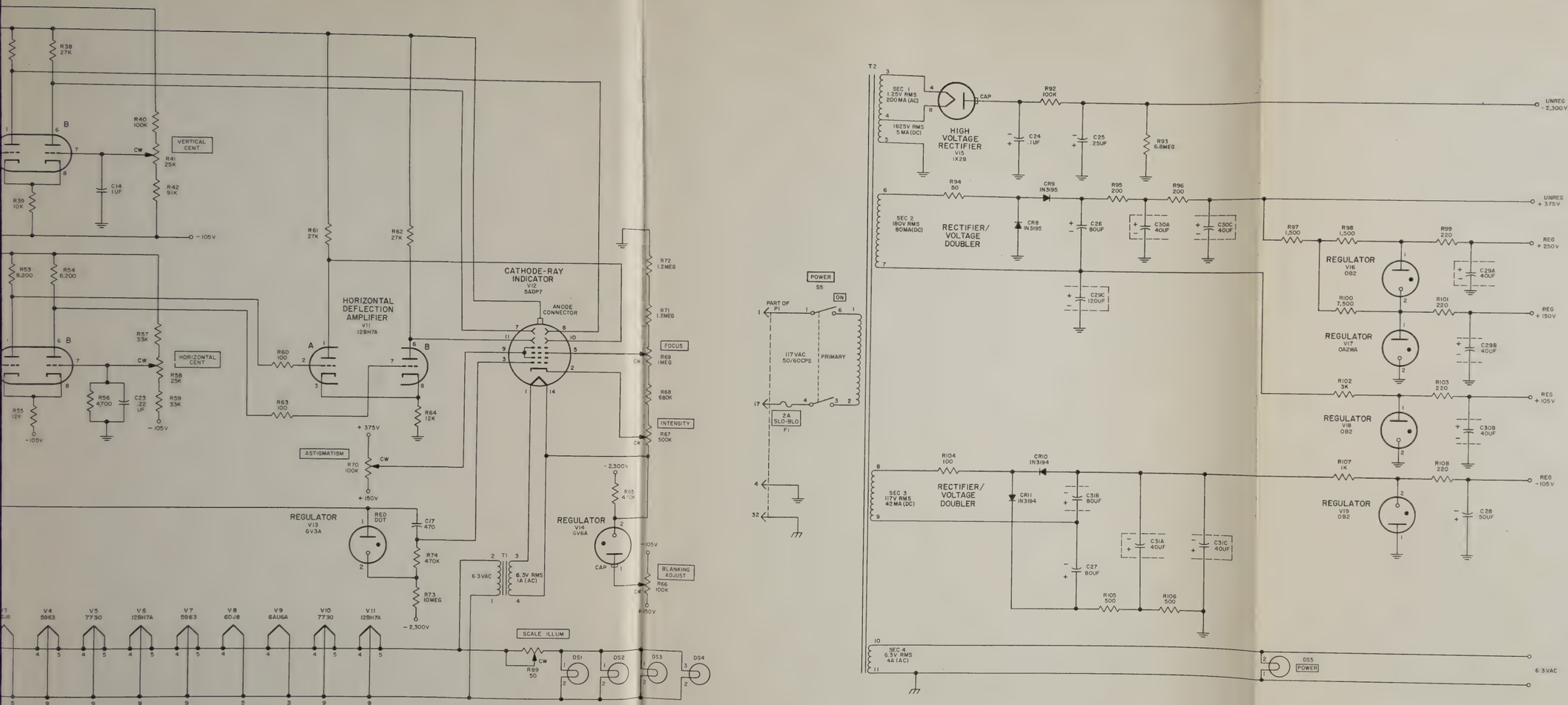


Figure 24. Oscillos



pe OS-119/GGM, schematic diagram.

NOTES

1. UNLESS OTHERWISE SPECIFIED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UUF
2. ▭ DENOTES EQUIPMENT MARKING.
3. ⏚ DENOTES CIRCUIT GROUND
4. ⏚ DENOTES CHASSIS GROUND
5. CW ON POTENTIOMETERS INDICATE DIRECTION OF CLOCKWISE ROTATION.
6. ALL ROTARY SWITCHES ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION VIEWED FROM FRONT OR KNOB END OF SWITCH. SECTION A (SWITCH S1) IS CLOSEST TO KNOB END

SWEEP OPTIONS
S1

SWITCH POSITION	CONTACTS MADE					
	S1A REAR			S1B REAR		
	X	Y	Z	X	Y	Z
AUTO	1-2	5-6	9-10,11	1-2,3	5-6,7	9-10
TRIGGERED	1-3	5-7	9-10,11	1-2,3	5-6,7	9-11,12
FREE	1-4	5-8	9-12	1-4	5-8	9-11,12

CHARACTER BLANKING SELECT
S2

SWITCH POSITION	S2 REAR		
	X	Y	Z
OFF	—	5-6	—
AUTO	1-3	5-7	9-11,12
MANUAL	1-4	5-8	9-11,12

INTERNAL SWEEP MILL-SECONDS COARSE
S4

SWITCH POSITION	S4 REAR	
	Y	Z
75-300	1-6	7-12
25-80	2-6	8-12
7.5-30	3-6	9-12
2.5-8	4-6	10-12
75-3	5-6	11-12

7 ARRANGEMENT OF ROTARY SWITCH SECTIONS.

8 PIN NUMBERS ON LAMPS DS1 THRU DS5 AND CONTACT NUMBERS ON ALL SWITCHES ARE ARBITRARILY ASSIGNED.

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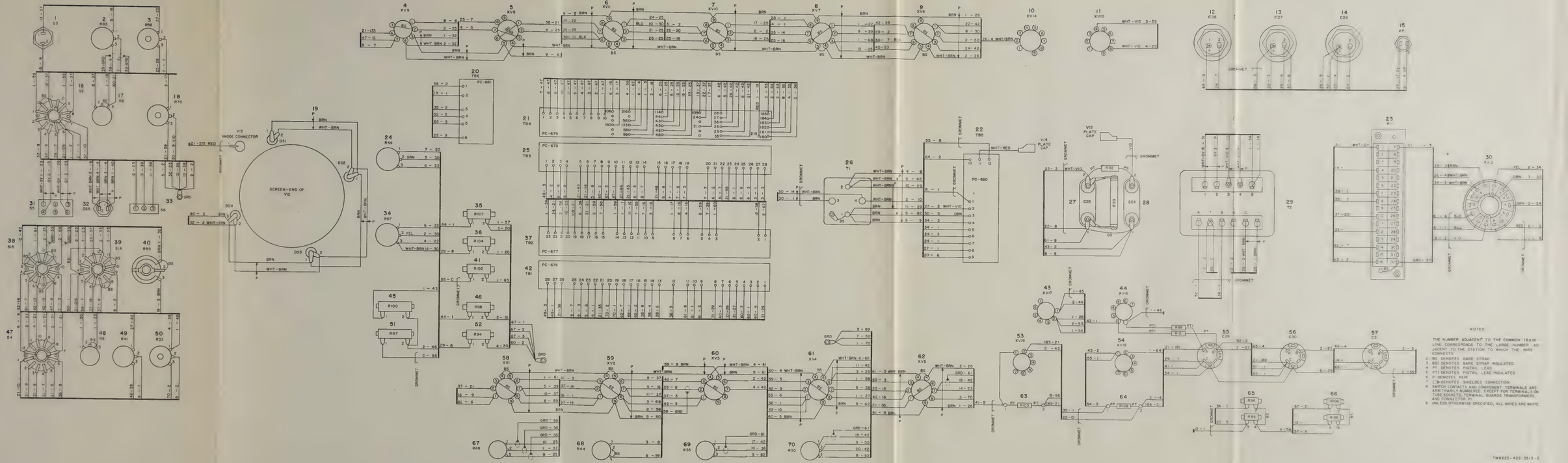

Figure 25. Oscilloscope OS-119/GGM, wiring diagram.

By Order of Secretary of the Army:

G. H. DECKER,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

DASA (6)
USASA (2)
CNGB (1)
Tech Stf, DA (1) except
CSigO (14)
Tech Stf Bd (1)
USCONARC (5)
USAARTYBD (1)
USAARMBD (2)
USAIB (1)
USARADBD (2)
USAAVNBD (1)
USABELCTBD (1)
USAATBD (1)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (3)
OS Base Comd (2)
LOGCOMD (2)
MDW (1)
Armies (2)
Corps (2)
Instl (2)
Ft Monmouth (63)
USATC AD (2)
USATC Armor (2)
USATC Engr (2)
USATC Inf (2)
USATC FA (2)
USAOMC (3)
Svc College (2)
Br Svc Sch (2)
GENDEP (2) except
Atlanta GENDEP (None)
Sig Sec, GENDEP (5)
Sig Dep (12)
WRAMC (1)
USA Trans Tml Comd (1)
Army Tml (1)
POE (1)
OSA (1)
USAEPG (2)
AFIP (1)
AMS (1)
Army Pictorial Cen (2)
EMC (1)
Yuma Test Sta (2)
USACA (3)
USASSA (20)
USASSAMRO (1)
USASEA (1)
USA Carib Sig Agcy (1)
USA Sig Msl Spt Agcy (13)
Sig Fld Maint Shops (3)
USA Corps (3)
Def Log Svc Cen (1)
JBUSMC (2)
Units org under fol TOE (2 Copies each UNOINDC):
11-7
11-16
11-57
11-97
11-117
11-155
11-157
11-500 (AA-AE) (4)
11-557
11-587
11-592
11-597

NG: None.
USAR: None.
For explanation of abbreviations used, see AR 320-50.